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STUDIES ON ESTER TRANSPOSITION (ETHANOLYSIS) IN COCONUT OIL: REACTION VELOCITY AND EQUILIBRIUM CONSTANTS[1]

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WITH TWO TEXT FIGURES

On alcoholysis coconut oil may yield at least eight ethyl esters and glycerol. The esters have possibilities as insect repellent, as insecticide, and as fuel, and the glycerol is important in medicine and in the manufacture of plastics. With the use of catalysts and high pressure, ethyl laurate is hydrogenated to lauryl alcohol, from which sodium lauryl sulfate is obtained. This latter compound is a widely used detergent marketed under such trade names as "Dreft" and "Lorol."

Review of literature

Reid (1938), and other investigators like Haller (1906), Perkins (1924), Stewart and McKinney (1931), and Tamayo (1930) are of the opinion that since glycerides have high molecular weights (tristearin, 891), heating one part of the glyceride with three to ten parts of either ethanol or methanol and a catalyst would transform most of the mixture to ethyl or methyl esters, depending upon which of the alcohols is used. Haller appears to be the author of the procedure for interesterification.

Reid (1938), who summarized the work on interesterification up to 1938, also states that the speed of esterification is approximately doubled with a rise in temperature of 10° C. Except in the case of high-boiling alcohols and acids, esterification cannot be effected at atmospheric pressure within a reasonable time without some other means of speeding up the reaction. Catalysts, such as a strong acid, either sulfuric or hydrochloric, may be used. He further reports that Ostwald in 1887 found that sulfuric acid appears to be only slightly more than half as effective as hydrochloric, whereas ethylsulfuric and ethylsulfonic rank with the strongest acids for esterifying an alcohol. Reid (1938) cites Weddige's concluding in 1895 that ammonia or pyridine can also catalyze alcoholysis and that in several patents metallic soaps are used as catalysts, whereas metals in the finely divided state are recommended by Gruber, Hadden, and others. Sudborough and Karve in 1922 found sodium alcoholate an effective esterification catalyst; the practice is to dissolve a small amount of sodium in anhydrous alcohol and

[1]Experiment Station Contribution No. 1491, presented by the senior author as thesis for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1947.

then add the ester (glyceride) afterwards. A small concentration of the catalyst effects the transformation of ester rapidly even at room temperature (Reid, 1938).

Purpose of the work

The experiment described in this report was conducted in the Agricultural Chemistry laboratory from November, 1946, to October, 1947, to make measurements on the reaction velocity constant and on the equilibrium constant for the reaction

$$\begin{array}{l} RCOOCH_2 \\ | \\ RCOOCH \\ | \\ RCOOCH_2 \end{array} + 3C_2H_5OH \rightleftharpoons \begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array} + 3RCOOC_2H_5$$

MATERIALS AND METHODS

Coconut oil. The oil was obtained from a Los Baños dealer. It was clear light yellow and had the following properties at 30° C.:

Specific gravity	0.9133
Refractive index	1.4524
Saponification No.	255.70

Chemicals. Ninety-five per cent ethyl alcohol, specific gravity at 30° C. = 0.8033; NaOH, C.P.; H_2SO_4, 95 per cent pure, specific gravity = 1.84; alcoholic KOH; standard acid and base; ether; and $NaHCO_3$.

Physical methods

Specific gravity. The specific gravities of the oil and the esters were determined by the use of pycnometers especially made for the purpose and calibrated at 30° C.

Refractive index. The *Officine Galileo* refractometer (No. 97361) of the Department of Chemistry, University of the Philippines, was used in determining the refractive indices.

Chemical methods

Determination of the saponification number. The method recommended in the *Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists,* fourth edition, 1935, was used.

Preparation of catalyst solutions of different normal concentrations. A 2N alcoholic sodium hydroxide solution was prepared by dissolving 25 grams of sodium hydroxide in 300 ml. of 95 per cent ethyl alcohol. The lower normalities were prepared by diluting the 2N alcoholic sodium hydroxide with alcohol.

Preparation of the pure ester. The mixed free fatty acids were first prepared. Twenty-four grams of sodium hydroxide was dissolved in 120 ml. of water; the solution was then slowly added to 100 ml. of coconut oil while the latter was stirred. The mixture was heated until it was clear and then poured into a separatory funnel containing 40 ml. of nitric acid diluted with 160 ml. of water. The lower layer was washed thrice with warm 10 per cent nitric acid and five times with hot water. The fatty acids thus prepared were dried with anhydrous sodium sulfate.

To the mixed free fatty acids were added twice their volume of 95 per cent ethyl alcohol and 4 per cent by volume of sulfuric acid. The mixture was shaken and refluxed slowly for 20 hours, after which it was washed three times with hot water, diluted with ether, washed with a 5 per cent sodium bicarbonate solution until no more bubbles were produced, and washed again with hot water to remove the impurities. The ether was removed by evaporation.

Construction of a curve showing relation between ester concentration and specific gravity. Synthetic mixtures of the pure ester and coconut oil were made by weighing the required amounts of ester and oil. The mixtures, covering the range 0 to 100 per cent ester in oil, were thoroughly shaken to form homogeneous solutions. Their specific gravities were plotted against the ester concentrations. The results are shown in figure 1. By means of this chart, the concentration of ester in an ester-oil mixture may be determined from the specific gravity of the mixture.

EXPERIMENTS AND DISCUSSION OF RESULTS

Theoretical aspect

The reaction treated in this paper consists of the following:

$$\begin{array}{l} RCOOCH_2 \\ | \\ RCOOCH \\ | \\ RCOOCH_2 \end{array} + \underset{\text{(alcohol)}}{3\ EtOH} \longrightarrow \underset{\text{(ester)}}{3\ RCOOEt} + \underset{\text{(glycerol)}}{\begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array}}$$

The notation may be simplified considerably into

$$\underset{\text{(oil)}}{O} + \underset{\text{(ethanol)}}{3A} \longrightarrow \underset{\text{(ester)}}{3E} + \underset{\text{(glycerol)}}{G}$$

The reaction is tetramolecular, there being one mole of oil and three of alcohol. The calculation of the reaction velocity constant for a tetramolecular reaction would be difficult; hence to simplify the work experimentally, a relatively large concentration of alcohol was used. In so doing the alcohol concentration would remain practic-

ally unaltered throughout the course of the reaction. Under such condition:

$$O \longrightarrow 3E + G$$

The reaction now is one of the first order (Getman-Daniels, 1943).

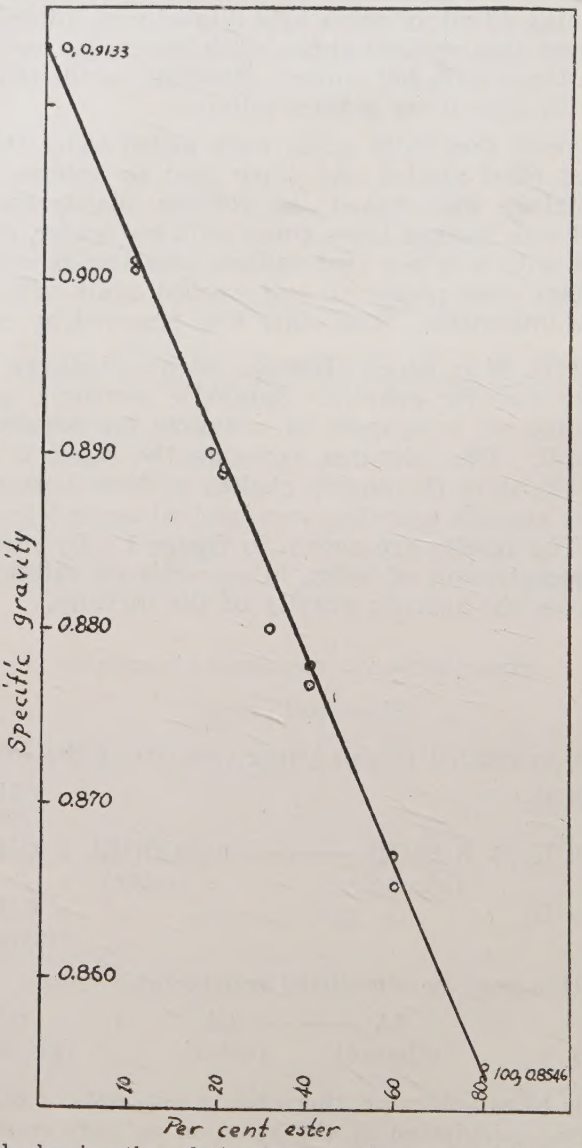


Fig. 1.—Graph showing the relation between the concentration of ester and the specific gravity of the oil-ester mixture.

If X = concentration of the oil, then the rate of change of

X with time t is, according to the usual mathematical treatment,

$$-\frac{dx}{dt} = kx$$

where k is the reaction velocity constant. The integration of this equation leads to

$$2.303 \log \frac{X_o}{X} = kt$$

where X_0 = initial concentration and X = concentration at any time t. Using specific gravities, $X_0 = d_0 - d\infty$ and $X = d - d\infty$ and therefore

$$kt = 2.303 \log \frac{d_o - d\infty}{d - d\infty}$$

where d_o = specific gravity of the coconut oil, d = specific gravity of the mixture of oil and esters at any time t; and $d\infty$ = specific gravity of the mixture of oil and esters at equilibrium time.

In the present study, measurements were made of d, d_o, and $d\infty$ at chosen times t, and an attempt was made to evaluate k from the equation

$$k = \frac{2.303}{t} \log \frac{d_o - d\infty}{d - d\infty}$$

The equilibrium constant. For the equilibrium reaction $O + 3A \longrightarrow 3E + G$, the equilibrium constant is given by the equation

$$K = \frac{C_E^3 \times C_G}{C_A^3 \times C_0}$$

The determination of the equilibrium constant consisted in varying the concentrations of oil (O) and alcohol (A), allowing the necessary time for equilibrium to be established, and then measuring the concentration of the esters (E) and glycerol (G) formed. The direct determination of esters and of the glycerol was found to be a problem by itself. Fortunately, pure esters could be prepared and since by washing with water, the reaction mixture may be made to contain only pure esters and unreacted oil, the concentration of ester in such mixture may be determined readily from a graph based on synthetic mixtures of pure esters and pure oil. Since there is a sufficiently large difference between the specific gravity of pure oil and that of pure esters, the specific gravity may be used as a measure of the ester concentration.

Further simplification in the calculations is possible if the reaction proceeds according to the reaction $O + 3A \longrightarrow 3E + G$. Once the number of moles of ester (E) is known, then the number of moles of glycerol (G) may be determined; it is equal to $\frac{\text{moles E}}{3}$. The number of moles of oil (O) that reacted is equal to the number of moles of glycerol, or $O = G$; the number of moles of alcohol (A) that reacted is equal to the number of moles of ester, or $A = E$. To summarize, it is only necessary to evaluate E. Then $G = E/3$, $O = G$, and $A = E$. If the total volume of the reaction mixture remains constant and is denoted by Y, then the corresponding concentrations are: for esters, $C = E/V$; for glycerol, $C = G/V$; for oil, $C = O/V$; and for alcohol, $C = A/V$. The equilibrium constant becomes:

$$K = \frac{(E/V)^3 \times (G/V)}{(A/V)^3 \times (O/V)}$$

which simplifies to

$$K = \frac{E^3 \times G}{A^3 \times O}$$

To hasten the reaction, chemically pure sodium hydroxide was used as the catalyst in this investigation. Other investigators have used sodium ethylate, sodium metal, and sodium hydroxide. The mechanism of the action of such catalysts is unknown; hence, the possible blocking of some oil molecules by the sodium hydroxide (soap formation) is not considered in this paper.

Molecular weights are necessary in the calculation of molar concentrations. The average molecular weight of oil is obtained from its saponification number, thus:

$$M(\text{oil}) = \frac{3 \times KOH}{\text{sap. no.}} = \frac{3 \times 46}{255.7} = 657$$

Since M(glycerol) = 92, and M(alcohol) = 46, and M(oil) + 3 M(alcohol) = 3 M(ester) + M(glycerol), therefore, 657 + (3 × 46) = 3 M(ester) + 92. Solving for M esters, the average molecular weight of the esters is calculated to be 234.

Experimental aspect
Preliminary experiments

Determination of homogeneous mixtures. Because a heterogeneous equilibrium would be difficult to study, conditions for obtaining homogeneous mixtures were first determined. The normal concentrations of the sodium hydroxide catalyst in the 95 per cent alcohol studied were 2, 1, 0.5, 0.25, 0.125, 0.0625, 0.03125, and 0.0078. The volume ratios of oil to alcoholic sodium hydroxide were 1:1, 2:1, and 1:2. The required volumes of oil and of alcohol

were mixed and observed up to 60 minutes to note whether a homogeneous mixture would result. During those 60 minutes the mixture was shaken for a minute every 9 minutes. The results are shown in table 1.

A number of mixtures were homogeneous, notably the 1:1 ratio of the 0.25N concentration, the 2:1 ratio of the 0.5N concentration, and the 1:2 ratio of the 0.25N and 0.125N concentrations.

Attempts to hasten the reaction. The specific gravity was found to be a sensitive means for detecting high concentrations of esters inasmuch as the pure ester had a specific gravity of 0.8542, whereas the pure oil had a specific gravity of 0.9133. The mere mixing of the oil and the alcohol gave only low concentrations of esters. To hasten the reaction and thus increase the concentration of the esters, (1) the reaction temperature was raised to the boiling point of the mixture, (2) the reaction time was extended to 12 hours, and (3) various modes of stirring were tried to prevent the reaction mixture from forming a gel and probably stopping the reaction or reversing itself (Getman-Daniels, 1943). Not one of these methods appeared to be successful in actual tests. The specific gravities showed that the reaction was not hastened satisfactorily.

The prior drying of the reaction product before its specific gravity was measured and found not to affect the results; samples were dried with anhydrous sodium sulfate and with activated silica gel in the belief that water dissolved in the reaction product may be the cause of high specific gravities. The results, however, indicated that water was not the cause of the high specific gravities.

Effect of adding oil to alcohol and vice versa. In repeated attempts to increase the concentration of esters, a difference was found between adding oil to alcohol and adding alcohol to oil. When oil was added to alcohol (with catalyst), the reaction product had a much lower specific gravity and consequently higher ester concentration than when alcohol was added to oil, although this was not always the case.

Evaluation of reaction velocity constant. When the oil was added to the alcohol, the specific gravity of the reaction product decreased in a matter of minutes. To follow up the reaction, 50 ml. of oil was poured into a 125 ml. Erlenmeyer flask containing 50 ml. of 0.5N sodium hydroxide in alcohol. The alcohol mixture was vigorously shaken while the oil was being poured. The mole ratio oil: alcohol in this mixture was 1:12. After exactly one minute from the start of mixing, 50 ml. of water was poured into the flask, thus arresting the course of the reaction. The procedure was re-

peated with the time from the instant of mixing to the pouring of the water, changed to 2, 3, 4, and 5 minutes (fig. 2).

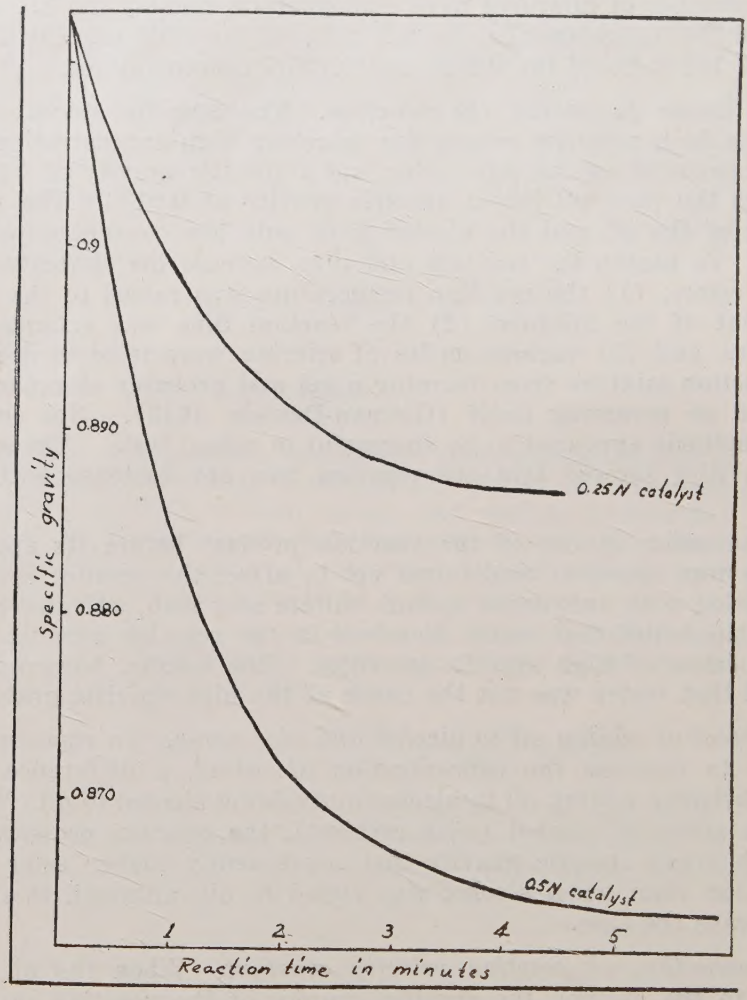


Fig. 2.—Graph showing the relation between the specific gravity of the oil-ester mixture and time of reaction.

The reaction product was separated from the aqueous layer and further washed with water until the wash water was clear. The

specific gravity was determined. The results are shown in table 2. The value of k was calculated from the equation

$$K = \frac{2.303}{t} \log \frac{d_o - d\infty}{d - d\infty}.$$ The

steps taken in the calculation and the calculated values of k are given in tables 3, 4, and 5. The values of k are summarized in table 6. Three catalyst concentrations, 0.125N, 0.25N, and 0.5N, were studied. Fairly constant values of k were obtained for a given catalyst concentration, although a sudden change usually took place in the value of k at the fourth minute. The value of k also tended to become smaller as the catalyst concentration was decreased. A low value of k is associated with low yields of esters (high specific gravities).

The average value of k for three determinations at one, two, and three minutes are 53.3 ± 1.20 for 0.5N catalyst, and 48.0 ± 1.22 for 0.25N catalyst. The corresponding reaction velocity equations are therefore

$$t = \frac{2.303}{53} \log \frac{X_o}{X} \text{ or } X = X_0 \, e^{-53t}$$

for the 0.5N catalyst,

and $$t = \frac{2.303}{48} \log \frac{X_o}{X} \text{ or } X = X_0 \, e^{-48t}$$

for the 0.25N catalyst. In these equations t is measured in minutes and X_0 and X, by specific gravity differences. The theoretical curves drawn from these equations are shown in figure 1. No equation was derived for the reaction at 0.125N catalyst concentration because the values of k were markedly erratic and showed a tendency to increase as reaction time increased.

The values of k obtained may be considered satisfactory, since coconut oil is not a single chemical compound but a mixture of compounds of varying molecular weights. Even reactions of some pure chemical compounds do not give constant values of k (Getman and Daniels, 1943).

The rate of reaction of oil and 95 per cent alcohol indicated that under favorable conditions, the mixture can reach equilibrium in five minutes at room temperature. Banzon[2], on the other hand, reported eight hours as the time it required to reach equilibrium for the same reaction at boiling temperature, using HCl as catalyst.

Measurements on the equilibrium constant. Coconut oil and alcohol were mixed in these varying proportions by moles: 2:3, 1:3,

[2] Banzon, J. On the reaction of coconut oil with ethanol. (Read before the Fourth Philippine Science Convention, February 25, 1937. Unpublished).

1:6, and 1:12. Convenient amounts of oil and alcohol (table 7) were measured, mixed while being stirred vigorously, then allowed to stand but with frequent stirring, and then heated for 30 minutes to reach equilibrium. Fifty ml. of water was now added to each mixture to arrest the reaction. The reaction product was thoroughly washed with water in a separatory funnel and dried, and the ester content determined by taking the specific gravity. The equilibrium constant was calculated in the following manner, using as example trial No. 1 (1:3 ratio) of table 7.

At the start:

$$\text{Moles O} = \frac{\text{V} \times \text{sp. gr.}}{\text{M}} = \frac{35.30 \times 0.9133}{657} = 0.0491$$

$$\text{Moles A} = \frac{\text{V} \times \text{sp. gr.}}{\text{M}} = \frac{8.55 \times 0.8033}{46} = 0.1493$$

$$\text{Moles E} = \text{O (zero)}$$

$$\text{Moles G} = \text{O (zero)}$$

At equilibrium:

$$\text{Moles E} = \frac{\text{V} \times \text{sp.gr.} \times \%}{\text{M}} = \frac{33.10 \times 0.9052 \times 0.1373}{234}$$

$$= 0.0176$$

$$\text{Moles G} = \frac{\text{moles E}}{3} = \frac{0.0176}{3} = 0.0059$$

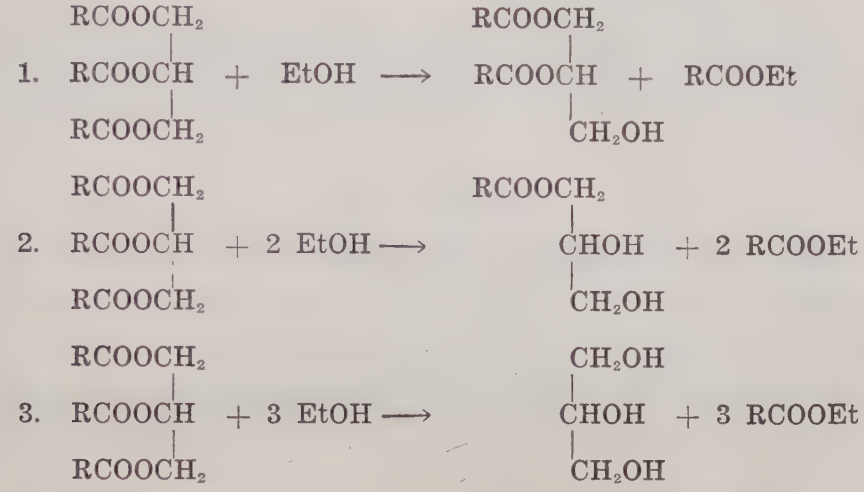
$$\text{Moles A} = \text{moles A at the start} - \text{moles A reacted}$$
$$= 0.1493 - 0.0176 = 0.1317$$

$$\text{Moles O} = \text{moles O at start} - \text{moles O reacted}$$
$$= 0.0491 - 0.0059 = 0.0432$$

$$\text{Therefore, } K = \frac{\text{E}^3 \times \text{G}}{\text{A}^3 \times \text{O}} = \frac{(0.0176)^3 \times 0.0059}{(0.1317)^3 \times 0.0432} = 3.29 \times 10^{-4}$$

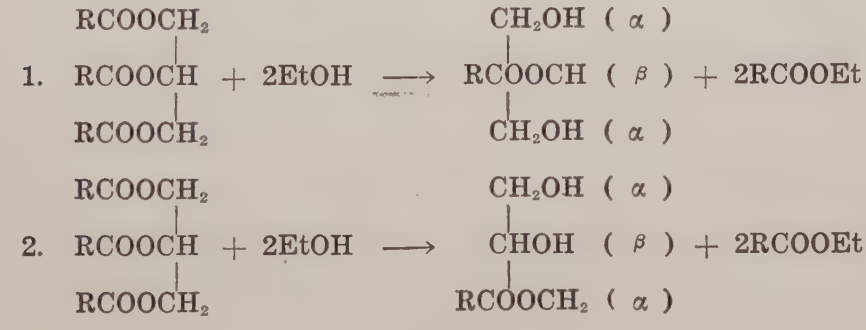
The results of these calculations (table 8) show that the most consistent values of calculated K were obtained at oil: alcohol mole ratios of 1:6 and 1:12. The results also indicate that K is not consistent but that there is a well-marked tendency for K to increase in value as the proportion of alcohol is increased. The explanation for this seems to be that the glyceride molecule (the oil) contains three reactive parts. If each part reacts independently of the others, then three reactions are possible with each of which may be asso-

ciated an equilibrium constant. The possible reactions might be the following:



If the number of moles of alcohol is limited, the chances are that reaction 1 or 2 will take place instead of reaction 3. As the number of moles of alcohol is increased (ratio 1:6 and 1:12), the chances that reaction 3 will take place will be increased also. If this explanation is correct, then a constant value of K cannot be obtained except when very high proportions of alcohol are employed.

Furthermore, there is a difference in chemical reactivity between the α positions and the β positions of the glyceride molecule (Hilditch, 1938), so that two reactions of different values of K are possible, depending upon whether the α, α or the α β positions are involved, thus:



SUMMARY

1. The rate of reaction of oil and 95 per cent alcohol under favorable conditions reached equilibrium in five minutes at room

temperature. The reaction velocity constants k obtained were 53.3 $\pm$ 1.20 for the 0.5N catalyst concentration, and 48.0 $\pm$ 1.22 for the 0.25N concentration.

2. In the calculation of the equilibrium constant K, the most consistent values were obtained at oil: alcohol mole ratios of 1 :6 and 1:12. The results also indicate that K was not consistent but had a tendency to increase in value as the proportion of alcohol was increased.

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TABLE 1

Effects of NaOH concentration and oil: alcohol ratio upon homogeneity of mixtures

NORMALITY OF NaOH	OIL : ALCOHOL					
	1:1		1:2		2:1	
	No. of phases	State	No. of phases	State	No. of phases	State
2	1	Solid	1	Solid	1	Solid
1	1	Solid	1	Solid	1	Solid
0.5	1	Solid	1	Liquid	1	Solid
0.25	1	Liquid	2	Liquid	1	Liquid
0.125	2	Liquid	2	Liquid	1	Liquid
0.0625	2	Liquid	2	Liquid	2	Liquid
0.0312	2	Liquid	2	Liquid	2	Liquid
0.0156	2	Liquid	2	Liquid	2	Liquid
0.0078	2	Liquid	2	Liquid	2	Liquid
0.0039	2	Liquid	2	Liquid	2	Liquid

TABLE 2

Specific gravities of the reaction product at different lengths of time, using various NaOH concentrations

NORMALITY OF NaOH	EXPERIMENT NO.	TIME IN MINUTES				
		1	2	3	4	5
		sp. gr.	*sp. gr.*	*sp. gr.*	*sp. gr.*	*sp. gr.*
0.5	1	0.8827	0.8715	0.8672	0.8639	0.8639
	2	0.8832	0.8719	0.8672	0.8638	0.8637
	3	0.8849	0.8751	0.8668	0.8636	0.8635
	Average	0.8836	0.8728	0.8671	0.8638	0.8637
0.25	1	0.8991	0.8940	0.8884	0.8883	0.8862
	2	0.8974	0.8911	0.8893	0.8861	0.8862
	3	0.8949	0.8906	0.8881	0.8891	0.8846
	Average	0.8971	0.8919	0.8886	0.8878	0.8863
0.125	1	0.9073	0.9042	0.9013	0.9001	0.8971
	2	0.9103	0.9058	0.9024	0.8992	0.8982
	3	0.9121	0.9068	0.9027	0.8973	0.8976
	Average	0.9099	0.9056	0.9021	0.8989	0.8976

TABLE 3

Calculation of reaction velocity constant, using 0.5N catalyst concentration according to the equation

$$K = \frac{2.303}{t} \log \frac{d_0 - d\infty}{d - d\infty}$$

EXPERIMENT NO.	t	SPECIFIC GRAVITY AT 30°C	$d - d\infty$	$\frac{d_0 - d\infty}{d - d\infty}$	$\log \frac{d_0 - d\infty}{d - d\infty}$	K
	min.					
	0	0.9133	—	—	—	—
	1	0.8827	0.0188	2.6277	0.41958	57.98
I	2	0.8715	0.0076	6.5000	0.71291	56.16
	3	0.8672	0.0033	14.9697	1.17522	54.13
	4	0.8639	—	—	—	—
	5	0.8639	—	—	—	—
	0	0.9133	—	—	—	—
	1	0.8832	0.0195	2.5441	0.40554	56.04
II	2	0.8719	0.0082	6.0488	0.78167	54.01
	3	0.8672	0.0035	10.1714	1.15141	53.03
	4	0.8638	0.0001	496.0000	2.69548	93.13
	5	0.8637	—	—	—	—
	0	0.9133	—	—	—	—
	1	0.8849	0.0214	2.3271	0.36682	50.69
III	2	0.8751	0.0116	4.2931	0.63277	43.72
	3	0.8668	0.0033	15.0909	1.17871	54.29
	4	0.8636	0.0001	498.0000	2.69723	93.22
	5	0.8635	—	—	—	—

TABLE 4

Calculation of reaction velocity constant, using 0.25N catalyst concentration according to the equation

$$K = \frac{2.303}{t} \log \frac{d_0 - d_\infty}{d - d_\infty}$$

EXPERIMENT NO.	t	SPECIFIC GRAVITY AT 30°C	$d - d_\infty$	$\frac{d_0 - d_\infty}{-d_\infty}$	$\log \frac{d_0 - d_\infty}{d - d_\infty}$	K
	min.					
	0	0.9133	—	—	—	—
	1	0.8991	0.0109	2.3028	0.36226	50.06
I	2	0.8940	0.0068	4.3276	0.63625	43.96
	3	0.8902	0.0020	12.5500	1.09864	50.60
	4	0.8883	0.0001	251.0000	2.39967	82.91
	5	0.8882	—	—	—	—
	0	0.9133	—	—	—	—
	1	0.8974	0.0113	2.4071	0.38150	52.72
II	2	0.8911	0.0050	5.4400	0.73560	50.82
	3	0.8893	0.0032	8.5000	0.92942	42.81
	4	0.8861	—	—	—	—
	5	0.8862	—			
	0	0.9133	—	—	—	—
	1	0.8949	0.0103	2.7864	0.44505	52.72
III	2	0.8906	0.0060	4.7833	0.67973	46.96
	3	0.8881	0.0035	8.2000	0.91381	42.09
	4	0.8891	0.0045	6.3778	0.80467	27.80
	5	0.8846	—	—	—	—

TABLE 5

Calculation of reaction velocity constant, using 0.125N catalyst concentration according to the equation

$$K = \frac{2.303}{t} \log \frac{d_0 - d_\infty}{d - d_\infty}$$

EXPERIMENT NO.	t	SPECIFIC GRAVITY AT 30°C	$d - d_\infty$	$\frac{d_0 - d_\infty}{d - d_\infty}$	$\log \frac{d_0 - d_\infty}{d - d_\infty}$	K
	min.					
	0	0.9133	—	—	—	—
	1	0.9073	0.0102	1.5882	0.20090	27.76
I	2	0.9042	0.0071	2.2817	0.35826	24.75
	3	0.9013	0.0042	3.8571	0.58626	27.00
	4	0.9001	0.0030	5.4000	0.73239	25.30
	5	0.8971	—	—	—	—
	0	0.9133	—	—	—	—
	1	0.9103	0.0121	1.2479	0.09618	13.30
II	2	0.9058	0.0076	1.9868	0.29815	20.60
	3	0.9024	0.0042	3.5952	0.55572	25.60
	4	0.8992	0.0010	15.1000	1.17898	40.73
	5	0.8982	—	—	—	—
	0	0.9133	—	—	—	—
	1	0.9121	0.0148	1.0811	0.03387	4.68
III	2	0.9068	0.0095	1.6842	0.22639	15.64
	3	0.9027	0.0054	2.9630	0.47173	21.73
	4	0.8973	—	—	—	—
	5	0.8976	—	—	—	—

TABLE 6

Summary of values of reaction velocity constant K for the NaOH normalities 0.5, 0.25, 0.125

NORMALITY	NO.	MINUTES				Av. *K* for 2, and 3 m.
		1	2	3	4	
0.5	1	57.98	56.16	54.13	—	
	2	56.04	54.01	53.03	93.13	
	3	50.69	43.72	54.29	93.22	
	Average	54.90	51.30	53.82	93.18	53.3
0.25	1	50.06	43.96	50.60	82.91	
	2	52.72	50.82	42.81	—	
	3	52.72	46.96	42.09	27.80	
	Average	51.50	47.25	45.17	55.36	48.0
0.125	1	27.76	24.75	27.00	25.30	
	2	13.30	20.60	25.60	40.73	
	3	4.68	15.64	21.73	—	
	Average	15.25	20.33	24.73	33.00	30.1

TABLE 7

Results of the experiment on equilibrium constant
A. Reactants

ITEM	OIL ALCOHOL			
	2:3	1:3	1:6	1:12
Oil, milliliters	42.33	35.30	28.24	21.18
Oil, moles	0.0588	0.0491	0.393	0.0294
Alcohol, milliliters	5.13	8.55	13.68	20.55
Alcohol, moles	0.0896	0.1493	0.2389	0.3589

B. Computation of number of moles of ester

TRIAL	ITEM	OIL ALCOHOL			
		2:3	1:3	1:6	1:12
I	Impure ester, specific gravity	0.9114	0.9052	0.8913	0.8629
	Impure ester, milliliters	41.07	33.10	24.60	18.36
	Impure ester, grams	37.4312	29.9621	21.9260	15.8428
	Pure ester, per cent	3.22	13.73	37.29	85.42
	Pure ester, grams	1.2053	4.1138	8.1762	13.5329
	Pure ester, moles	0.0051	0.0176	0.0349	0.0578
II	Impure ester, specific gravity	0.9114	0.9054	0.8906	0.8618
	Impure ester, milliliters	41.55	33.80	24.15	18.43
	Impure ester, grams	37.8687	30.6025	21.5080	15.8830
	Pure ester, per cent	3.22	13.39	38.47	87.29
	Pure ester, grams	1.2194	4.0977	8.2741	13.9643
	Pure ester, moles	0.0052	0.0175	0.0354	0.0592
III	Impure ester, specific gravity	0.9088	0.9093	0.8899	0.8611
	Impure ester, milliliters	41.70	33.00	24.00	18.50
	Impure ester, grams	37.8970	30.0069	21.3576	15.9304
	Pure ester, per cent	7.63	6.78	39.66	88.47
	Pure ester, grams	2.8915	2.0345	8.4704	14.0936
	Pure ester, moles	0.0124	0.0087	0.0362	0.0602

TABLE 8

Calculation of the number of moles of reactants and products for the equilibrium constant

NO. OF MOLES	OIL : ALCOHOL											
	2:3			1:3			1:6			1:12		
	1	2	3	1	2	3	1	2	3	1	2	3
At start												
Oil.....	0.0588	0.0588	0.0588	0.0491	0.0491	0.0491	0.0393	0.0393	0.0393	0.0294	0.0294	0.0294
Alcohol.....	0.0896	0.0896	0.0896	0.1493	0.1493	0.1493	0.2389	0.2389	0.2389	0.3589	0.3589	0.3589
Ester.....	0	0	0	0	0	0	0	0	0	0	0	0
Glycerol.....	0	0	0	0	0	0	0	0	0	0	0	0
At end												
Oil.....	0.0571	0.0571	0.0547	0.0432	0.0433	0.0462	0.0277	0.0275	0.0272	0.0101	0.0097	0.0093
Alcohol.....	0.0845	0.0844	0.0772	....	0.1318	0.1406	0.2040	0.2035	0.2027	0.3011	0.2997	0.2987
Ester.....	0.0051	0.0052	0.0124	0.0176	0.0175	0.0087	0.0349	0.0354	0.0362	0.0578	0.0592	0.0602
Glycerol.....	0.0017	0.0017	0.0041	0.0059	0.0058	0.0029	0.0116	0.0118	0.0121	0.0193	0.0197	0.0201
K	6.54×10^{-6}	6.96×10^{-6}	3.11×10^{-4}	3.29×10^{-4}	3.17×10^{-4}	1.49×10^{-5}	2.11×10^{-3}	2.25×10^{-3}	7.49×10^{-3}	1.38×10^{-2}	1.57×10^{-2}	1.79×10^{-3}
Av. K[a]	6.75×10^{-6}			3.23×10^{-4}			3.95×10^{-3}			1.04×10^{-2}		

[a] Average K was computed from the consistent values of K only.

KENAF (*HIBISCUS CANNABINUS* LINN.) CULTURE IN THE COLLEGE OF AGRICULTURE AT LOS BAÑOS[1]

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WITH ONE TEXT FIGURE

Kenaf, *Hibiscus cannabinus* Linn., a promising source of soft fiber which the Philippines needs for export and for home consumption, has been grown successfully in the Experiment Station of the College of Agriculture at Los Baños, Laguna. The plant is a tall herbaceous annual of the Mallow family (Malvaceae). Under Los Baños conditions, yields of about five tons of dry fiber to a hectare can be produced in 120 to 150 days. According to Goulding (1919) and Nicholls (1929), the fiber, which is extracted by retting, can be used for most purposes for which the jute fiber is ordinarily employed in the manufacture of coarse fabrics, such as sacking, burlap, and twine. The Philippines needs kenaf fiber to meet her requirements for large-scale production of sacking.

The present paper reports the results of a preliminary trial conducted from June, 1947, to January, 1948 in the Experiment Station and in the fiber laboratory of the Department of Agronomy to study the response of the kenaf plant to certain methods of culture and different rates of seeding.

Review of literature

According to Goulding (1919), the *Hibiscus cannabinus* Linn. which is cultivated in India, Africa, and many other tropical countries, is one of the important jute substitutes. Its yield varies from 2 to 3 tons of fiber an acre (4.94 to 7.41 tons a hectare). The fiber is exported to the United Kingdom under the name of "Bimlipatam jute." Kenaf fiber is somewhat coarser than true jute, but it can be used for most purposes for which jute is ordinarily employed.

Nicholls (1929) states that for fiber production *Hibiscus cannabinus*, "Deccan hemp," or "Bimlipatam jute" requires three or four months to reach maturity. If cut when mature, it yields a strong fiber. The stems are usually cut at the flowering stage. In India the estimated yield is from 1½ to 3 tons an acre (3.71 to 7.41 tons a hectare). Kenaf fiber is considered as good as, and possibly superior to, the average jute, for which kenaf is used as a substitute in the manufacture of cordage, sacking, or any of the coarser textiles.

[1]Experiment Station Contribution No. 1492.

Crane and Acuña (1945) in Cuba identified two varieties of kenaf, *viridis* and *vulgaris*. These two varieties are alike except in their leaves: the *viridis* is characterized by cordate leaves only, whereas the *vulgaris* possesses both cordate and palmately lobed leaves. Although these authors noted that the time and the distance of planting have little influence on the branching of *viridis* and *vulgaris*, they state that planting can be done at the beginning of the rainy season. For high yield of seeds they recommend drilling the seeds in rows 20 to 24 inches apart, and 2 or 3 inches between hills in the row. For maximum yield of kenaf fiber, Crane, Acuña, and Alonso (1946) recommend planting in May or earlier if the moisture supply is adequate, in rows 8 inches apart at the rate of 30 to 35 pounds of seed to the acre. These authors found that the yield of fiber increases as the distance between the rows is decreased. Crane and Acuña (1945) and Ergle, Robinson, and Dempsey (1945) in Alabama found greater yields of fiber from the kenaf plant than from several other fiber plants.

Watkins (1946) reported that the planting distance of 12 × 2 inches gave better quality fiber and needed less weeding than any other spacing. He found that the heights of the plants and their fiber content increased as the planting distance was increased. The percentage of fiber in the total green weight was inversely related to the height and fiber content of the plant.

TRIAL PLANTING AND RESULTS

The kenaf seed used in the trial planting was secured through the courtesy of Mr. Joe E. Walker, Agronomist, Foreign Agricultural Relations, U. S. Department of Agriculture in Cuba.

The soil of the field used is clay loam, fairly well drained and previously planted to corn. The land was plowed three times with a Philippine plow and harrowed several times after each plowing. The prepared field was divided into four blocks of 1 × 10 meters each for the four rates of seeding in randomized plot arrangements, and replicated five times.

On June 4, 1947, the seeds were broadcast rather thickly on the plots, covered lightly with soil, and then compacted with a small homemade wooden roller.

The seeds germinated five days from sowing and when the seedlings were 15 centimeters high, they were thinned to 15 plants in Plot I, 50 in Plot II, 60 in Plot III, and 70 in Plot IV, corresponding to seeding rates of 2.27, 7.57, 9.09, and 10.60 gantas a hectare, respectively. One ganta contains 66,000 seeds and weighs 1.776 kilograms.

No cultivation was found necessary because all the big weeds were pulled up during the thinning of the seedlings and the plants grew so fast that there was little chance for the weeds to grow, especially in the thickly seeded plots.

As to the climatic conditions during the period of this trial, the climatological data of the College of Agriculture for June to November, 1947, furnished by the Weather Bureau in Manila, were as follows:

Total average rainfall, 257.0 mm.
Minimum and maximum temperature, 22.8° C. and 30.7° C.
Wind velocity, 7.5 miles per hour.
11 days partly cloudy and 19 days cloudy a month.

An examination of 1878 plants of *Hibiscus cannabinus* from the different plots showed that 18.2 per cent produced cordate and shallowly lobed leaves (fig. 1, right), and 81.8 per cent produced both cordate and palmately lobed leaves (fig. 1, left). According to Crane and Acuña (1945), variety *viridis* is characterized by cordate leaves only and variety *vulgaris* by cordate and palmately lobed leaves. Both varieties have prickly stems of practically the same length and growth habit, color of the leaves, stems, flowers, and percentage of fiber. Most of the plants in the different plots were in flower on October 16, 1947, or 134 days after being planted.

The flowers are solitary, borne on short peduncles at the axils of the leaves. The corolla is simple, composed of five large petals thickened and crimson to purplish at the base and thin, broad, and yellowish white from the center to the tip.

The seeds are somewhat glabrous, angular, dull gray with raised small brown spots, and a small hilum (Crane and Acuña, 1945).

Time of flowering. From September 16 to October 31, 1947, daily counts of plants that flowered and those which did not flower (table 1) indicated that of the four rates of seeding, Plot 1, with 15 plants to a square meter, bloomed first, in 104 days from planting, and was through flowering in 30 days. In Plot II with 50 plants to a square meter, Plot III with 60, and Plot IV with 70, the plants flowered in consecutive order one to five days later and finished flowering in 43, 42, and 40 days, respectively. All plots were in full bloom 134 days after planting. Plot IV had the greatest number of plants that did not flower, apparently owing to crowding, whereas all the plants in Plot I flowered. As the rate of seeding was increased there was a progressive decrease in the number of plants that flowered, indicating that in kenaf-seed production, the rate of seeding should be considered.

Height of the plants. The first cutting of the plants from each replication plot was made when Plot I began to bloom. Most of the plants, however, were cut when their seeds were mature. Five representative samples of ten plants each were cut close to the ground. There was no significant difference in the mean heights of the plants of varieties *viridis* and *vulgaris*. An analysis of the effect

on the mean heights of the two varieties of the rate of seeding taken when they were 108 days old (table 2) showed that as the number

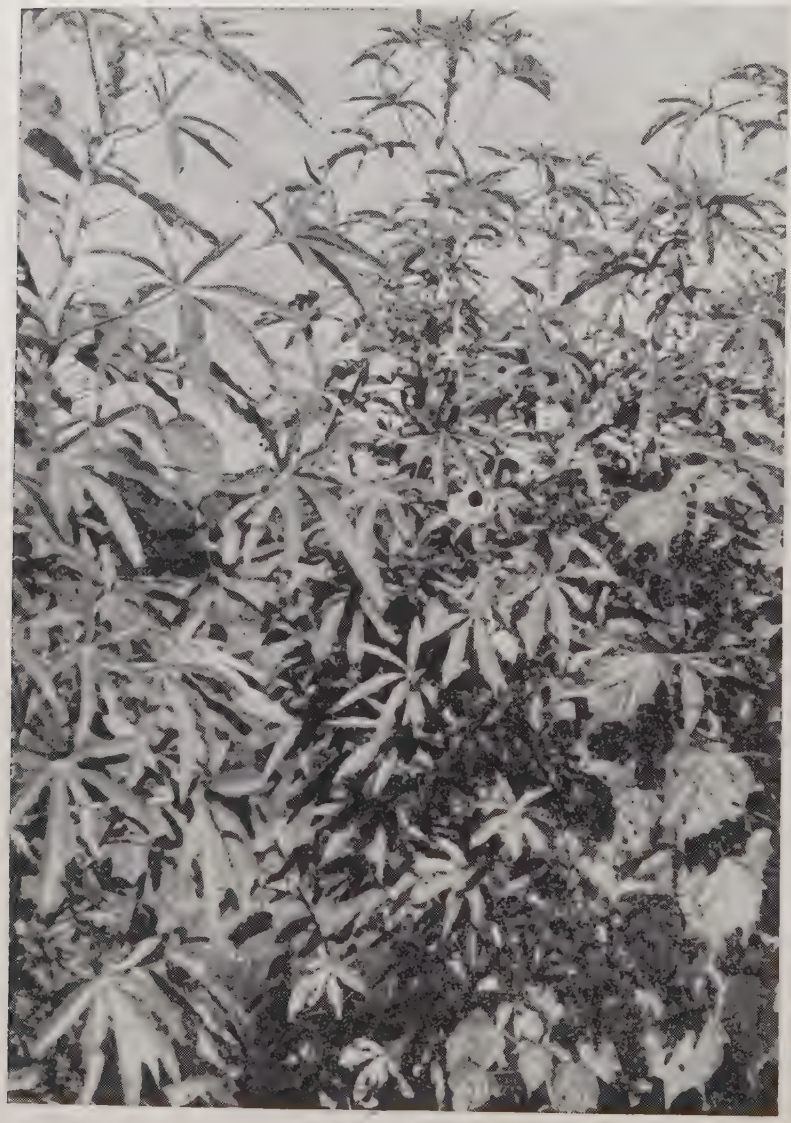

Fig. 1. — *Hibiscus cannabinus* var. *viridis* (right) and var. *vulgaris* (left) 110 days after planting at the College of Agriculture Experiment Station, Los Baños. *Photographed by Dean L. B. Uichanco, September 22, 1947.*

of plants was increased from 15 plants to a square meter in Plot I to 50 in Plot II, and 60 in Plot III, there was a significant increase in the mean height of the plants. No marked difference in their mean heights was noted when the plants in Plots II and III were compared. However, when seeding was at the rate of 70 plants to a square meter in Plot IV, the mean plant height was statistically less than that when the rate was 50 (Plot II) and 60 (Plot III). Evidently, crowding 70 plants in a square meter did not permit their normal growth and development. Under soil and climatic conditions of the College of Agriculture Experiment Station, the mean height of the plants indicated that the optimum rate of seeding was 50 or 60 plants to a square meter.

Branching of the plants. Table 2 shows that the rate of seeding influenced the degree of branching and the production of seeds. Analyzed statistically, the highest percentage of branching was in Plot I of 15 plants to a square meter, and the lowest in Plot IV of 70 plants. Although there was no significant difference between the averages of the number of plants that produced branches in Plot II (50 plants to a square meter) and in Plot III (60 plants), there were significantly more plants in Plot II that branched than in Plot IV. As reported by Crane and Acuña in 1945, there was a tendency for reduced branching as the number of plants to a square meter was increased. The relation of rate of seeding to fiber or seed production of kenaf is of importance.

Length of the stems. Analysis of the measurements of stems of ten plants harvested at random from the different plots after flowering to determine the effect upon average length of rates of seeding (table 2) indicated significant corresponding increases as the number of plants in each square meter was increased from 15 in Plot I to 50 in Plot II, and 60 in Plot III. The plants in Plots II and III did not show marked difference in the mean lengths of the stems. When, however, 70 plants were set in a square meter as in Plot IV, the stems became shorter than those in Plots II and III.

Diameter of the stems. The effect of the rate of seeding on the mean diameter of the stems of ten plants harvested at random from each plot replication measured 10 centimeters above the ground (table 2) showed that the average diameter tended to decrease as the rate of seeding was increased. The greatest stem diameter was obtained in Plot I of 15 plants to a square meter and the least in Plot IV of 70 plants. Plants in Plot II and Plot III did not produce any significant mean difference in diameter of stems. A highly significant mean difference was noted when comparison was made of the stem diameters of plants seeded at the rates of 15, 50, and 60 plants to the square meter and of those seeded at 70 plants to the same unit area.

Number of capsules on a plant. The average number of seed capsules borne by 10 plants taken at random from each plot (table 2) indicated that as the number of plants to a square meter was increased, the mean number of capsules on the plants decreased. The number of capsules on each plant was greatest in Plot I and least in Plot IV. Statistical analysis showed that the plants in Plot II and Plot III had no significant mean difference in number of capsules; but when the rate of seeding was increased to 70 plants to a square meter, the mean number of capsules to a plant decreased significantly.

Number of seeds in a capsule. When the plants were mature and had shed the majority of their leaves, they were cut and brought to the laboratory, and the seeds of 500 capsules taken at random from each plot were counted. The results in table 2 show that the average number of seeds in the capsule increased with the reduction of the rate of seeding. The greatest number of seeds in a capsule was obtained in Plot I, which had 15 plants to a square meter, and the smallest number in Plot IV, which had 70 plants to a square meter. The difference between the means of the number of seeds in a capsule of plants in Plot II, and of Plot III was insignificant. Seeding at the rates of 50 and 60 plants to a square meter produced more seeds to a capsule than the rate of 70 plants to a square meter.

Percentage of dry fiber in a plant. After the stalks had been measured and weighed, they were tied in bundles and submerged in running water for 10 to 18 days to ret. After retting, the fibers were separated from the woody part of the stems, adhering parts of the bark removed, washed, and dried in the sun to a constant weight. Retting the bark after removing it from the stalks was also tried. Although it produced better and cleaner fiber, the process was tedious and expensive. The percentages of dry fiber in a plant in relation to the rate of seeding (table 2) indicated a tendency to increase with the decrease in seeding rate. Thicker and longer stems were produced in Plot I, with 15 plants to a square meter, than in Plot IV, with 70 plants to the same area. This difference in length and diameter of the stems may account for the higher percentage of dry fiber in Plot I than in Plot IV.

The average percentages of clean fiber when the plants were 118, 128, 138, 148, and 158 days old were 3.9, 4.5, 6.7, 7.1, and 7.6 per cent, respectively, giving a difference of 0.66 as a required value for significance at 5 per cent point. The results corroborate those of Crane, Acuña, and Alonso (1946), who noted that the percentage of fiber in green weight increased as the plants became older.

Yield of clean dry fiber. Five sample areas of 30 $\times$ 30 centimeters were taken from each of the four plots and the average weight in grams of the clean dry fiber of each plant when it was in

full bloom was determined. As shown in table 2, the amount of fiber in a plant decreased as the rate of seeding was increased. Planting kenaf at the rate of 15 plants to a square meter gave significantly more fiber than any of the other rates of seeding. As noted by Watkins (1946), the dry-fiber yield of a plant was inversely proportional to the percentage of fiber in the total green weight, which increased as the number of plants to a square meter was increased.

The result of this trial showed that at the rate of 15 plants to a square meter, a hectare kenaf would yield 3.53 tons; at 50 a square meter, 4.70 tons; at 60, 3.90 tons; and at 70, 2.24 tons. The high unit yield in Plot I shown in table 2 was more than offset by the greater number of plants in a square meter in Plots II and III. Although Plot IV had the greatest number of plants, the plants were smaller and yielded only an average of 3.2 grams each. Each plant in Plot I gave a yield 2.5 times as large as that in Plot II. This difference, however, was not great enough to compensate for the larger number of plants to a square meter in Plot II. From the results of this trial, the writer believes that under soil and climatic conditions in the College of Agriculture Experiment Station, kenaf for fiber production should be planted at the rate of 50 plants to a square meter.

Diseases and pests. No diseases were observed in the different plots. Of the insect pests the following were found: (1) *Nisotra gemella* Erichson,[2] Chrysomelidae, Coleoptera; (2) *Saissetia nigra* Nietner, Coccidae, Homoptera; (3) *Tectocoris diopthalmus* (Thunberg), Pentatomidae, Hemiptera; (4) *Dysdercus megalopygus* Breddin, and *D. Poecilus* Herrich-Schaeffer, Pyrrhocoridae, Hemiptera; (5) *Phaneroptera furcifera* Stal. Tettigoniidae, Orthoptera. Although these insects appeared to be fond of kenaf, they did not damage the plants extensively.

It was also observed that kenaf did not lodge and was not seriously affected by the strong wind of October 31, 1947.

SUMMARY

1. Small trial plantings of kenaf, *Hibiscus cannabinus* Linn., were made in the College of Agriculture Experiment Station with seeds of two varieties, *viridis* and *vulgaris*, introduced from Havana, Cuba.

2. The kenaf plant required a simple method of cultivation and its fiber was extracted by ordinary retting.

3. The height of the plants, their branching, the length and diameter of the stems, the number of capsules, and the percentage

[2]Determination by the Department of Entomology, College of Agriculture.

and the yield of dry fiber of each plant were affected by the rate of seeding or spacing between plants. At the rate of 50 and 60 plants to a square meter no significant difference from each other of these agronomic characters was noted, although they were better than those seeded with 70 plants to a square meter.

4. For seed production, kenaf should be planted at the rate of 15 to 50 plants a square meter and for fiber production, 50 plants to a square meter.

5. No serious diseases and insect pests were observed during the experiment.

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TABLE 1

Flowering time, number of plants that flowered, and the percentage of plants without flowers 149 days after planting

PLOT	NUMBER OF PLANTS TO A SQUARE METER	FLOWERING TIME AFTER DATE OF PLANTING	PLANTS THAT		
			flowered	did not flower	
		days	*number*	*number*	*per cent*
I	15	104-134	149	1	0.66
II	50	105-148	472	28	5.60
III	60	107-149	530	70	11.66
IV	70	109-149	442	258	36.85

TABLE 2

Mean values of the quantitative characters measured in four plots

PLOT	NUMBER OF PLANTS TO A SQUARE METER	AVERAGE HEIGHT OF PLANTS AT 108 DAYS OF AGE	PERCENTAGE OF BRANCHING	AVERAGE LENGTH OF HARVESTED STEMS	DIAMETER OF CUT STEMS	NUMBER OF CAPSULES TO A PLANT	NUMBER OF SEEDS TO A CAPSULE	PERCENTAGE OF DRY FIBER	YIELD OF CLEAN DRY FIBER BY A PLANT
		cm.		*cm.*	*mm.*				*grams*
I	15	223.2	62.9	235.1	21.8	50.2	22.6	5.3	23.5
II	50	240.9	22.9	280.5	19.1	26.7	21.3	5.8	9.4
III	60	243.6	13.7	279.3	17.3	23.5	20.5	6.3	6.5
IV	70	217.4	5.1	221.7	12.0	9.6	17.7	6.4	3.2
Least significant mean difference [a]		14.81	11.30	20.76	4.66	11.04	1.71	0.59	11.33

[a] Based on the value of *t* at 5 per cent level of significance.

STUDY OF MENDELIAN BIOTYPES IN THE SEGREGATING GENERATION OF TOMATO HYBRIDS[1]

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The present study which is a continuation of the investigations reported by Capinpin and Sison (1947) was undertaken with a view of studying the combinations and recombinations of observable plant and fruit characters in the segregating generation of tomato hybrids involving the Native, Susong Kalabaw, and Kamatis na Ligaw.

Studies conducted elsewhere on hybrids of standard varieties of tomatoes were reported by Helper (1929), Yeager (1937), Hackbarth (1940), and Meyer and Peacock (1941). The genetics of fruit size inheritance was pointed out by MacArthur (1941), Powers (1941), Butler (1941), and Larson and Currence (1944). MacArthur and Chiasson (1947) studied the fertility, crossability, appearance, sterility, and cytology of some interspecific hybrids of the cultivated and the newly introduced wild species of tomatoes.

EXPERIMENTS, RESULTS, AND DISCUSSION

The seeds of the following tomato strains were grown and the resulting plants studied:

Native (parental seeds)
Susong Kalabaw (parental seeds)
Kamatis na Ligaw (parental seeds)
F_2 segregates (Native×Susong Kalabaw)
F_2 segregates (Native×Kamatis na Ligaw)

All plants were raised under the same soil and climatic conditions and were given the same treatment.

Observations on the second-generation hybrid populations were made regarding the dates of flowering, the periods of fruiting and maturing, the number of fruits, and the resistance to diseases and pests of each strain.

Segregation of plant and fruit characters of each of the hybrid types

Plant habit. The F_2 segregations according to plant habits in the hybrid (Native × Susong Kalabaw) F_2 were noted. The F_2 hybrid segregates were classified into tall and branchy plants. One hundred two plants were studied and statistically treated for factorial analysis.

[2] Experiment Station Contribution No. 1493. Portions of the data used here were included in a thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1947. Read by the senior author before the Los Baños Biological Club on February 20, 1948.

The hybrid (Native × Kamatis na Ligaw) F_2 was segregated into spreading (bushy) and less spreading (not bushy). One hundred five plants of this hybrid were used for study.

For laboratory study, five fruits were taken from each hybrid plant and their measurable characters were observed. The following characters of the fruit of each hybrid were noted.

Fruit shape. The fruit shape of the cross between Native and Susong Kalabaw was classified into normal (generally spherical) and fasciated (nonspherical), and that of the cross between the Native and Kamatis na Ligaw into ridged (non-spherical) and non-ridged (spherical). The F_2 segregations of the hybrid types were noted and tested for closeness of fit to interpret the Mendelian ratio in heredity.

Fruit locules. The fruits of each hybrid type were cut open crosswise and the number of locules in each was counted. Each fruit was classified as many-loculed or two-loculed. Segregation was noted and interpreted in the Mendelian ratio of inheritance by testing it for closeness of fit.

Fruit size. The size of the fruits of each hybrid type was measured. The polar diameter was determined by measuring the vertical distance from the base to the tip of each fruit. The equatorial diameter was measured by taking the horizontal distance across the greatest width of the fruit. Each fruit was weighed after the polar and equatorial diameters had been taken.

Data of all measurable plant and fruit characters were classified and subjected to statistical analysis.

Observations on second generation population

Fluctuation and percentage of germination of the five strains. The percentages of germination based on 500 seeds of each strain sown on the seedbox were as follows: Native, 19 per cent; (Native × Susong Kalabaw) F_2, 28 per cent; (Native × Kamatis na Ligaw) F_2, 37 per cent; Susong Kalabaw, 16 per cent; and Kamatis na Ligaw, 35 per cent. With the exception of Kamatis na Ligaw, which had a higher percentage of germination than (Native × Susong Kalabaw) F_2, this record shows that the percentage of germination of the hybrid seeds is higher than that of the parental types.

Relative dates of flowering of the five strains. Capinpin and Sison (1947) observed that the F_1 hybrids flowered earlier than any of the parents. More of the (Native × Kamatis na Ligaw) F_2 plants flowered earlier than any of the other strains. More of the Kamatis na Ligaw, an early fruiting strain, flowered earlier than the hybrid (Native × Susong Kalabaw) F_2 during the first two weeks of observation. This finding seems to corroborate the find-

ings of Wellington (1912) with respect to earliness of several tomato crosses.

Relative periods of fruiting and maturing of fruits of the five strains. More of the hybrid (Native × Kamatis na Ligaw) F_2 formed fruit the earliest among the strains. Kamatis na Ligaw during the first two weeks had more plants fruiting than the hybrid (Native × Susong Kalabaw) F_2. The two parents, Native and Susong Kalabaw, had not yet formed a single fruit, whereas the two hybrids had already set several fruits.

There were more plants of the two hybrids that matured earlier than their parents, with the exception of Kamatis na Ligaw, which apparently had more plants with mature fruit during the first week of observation.

Quantity of fruit produced by each of the five strains. Twenty representative plants of each strain were used in the count made of the average number of fruit.

The Native was found to be the poorest producer. The two hybrids produced more than the Native but were less productive than their respective male parents, the Kamatis na Ligaw and the Susong Kalabaw. Kamatis na Ligaw produced the greatest number of fruit among the strains. This result is in conformity with the findings of Helper (1929) and Meyer and Peacock (1941).

Testing the closeness of fit for typical Mendelian hypothesis

In the F_2 hybrid populations the fruit and plant characters were distinguishable mostly on the basis of two phenotypes. In Mendelian heredity, the phenotypic ratios that are in accordance with factorial analysis are the following: 3 : 1 for monohybrid or monogenic inheritance; 9 : 7 for dihybrid or digenic; and 37 : 27 for trihybrid or trigenic. The closeness of fit was tested according to these segregating ratios, and the factorial analysis deduced from the ratios that gave the best or closest fit. The statistical procedure adopted is the chi-square test.

The F_2 segregation into tall and branchy plants of a cross between the Native and Susong Kalabaw is shown in table 1. Observations were conducted after the plants had reached the most vigorous stage of growth. Of the total of 102 plants studied, 77 plants were tall and 25, branchy. This result was tried in 3: 1, 9: 7, and 37: 27 fittings by the chi-square. The character was found to be monogenic or monofactorial in heredity segregating in a 3: 1 ratio, with the tall ones dominant over the branchy plants. The value of X^2 was 0.01306, with a probability of 94.09 per cent.

The segregation into spreading and less-spreading plants of the cross between the Native and the Kamatis na Ligaw is shown in table 2. Of 105 plants studied, 77 were spreading and 28, less

spreading. When tested for closeness of fit, these figures gave a close fitting for a 3: 1 ratio with an X^2 value of 0.1554, corresponding to a probability of 79.80 per cent. The character was found to be monogenic in inheritance, segregating in a 3: 1 Mendelian ratio in favor of spreading. The result shows that spreading character appeared to be dominant over the less spreading in the F_2 generation.

In the hybrid (Native $\times$ Susong Kalabaw) F_2, 510 fruits, or 5 fruits each from 102 plants, were studied. Of these fruits, 383 were normal (generally spherical) and 127, fasciated (nonspherical) (table 3). The chi-square test gave a very close fit for the 3: 1 ratio, with an X^2 value of 0.002513 and a probability of 96.50 per cent. The fruit shape was found to be a monogenic factor, segregating in a 3: 1 ratio in favor of normal shape.

The F_2 fruit-shape segregation of a cross between the Native and Kamatis na Ligaw and the chi-square test are shown in table 4. Five fruits each from 105 plants, or 525 fruits, were observed and studied. Of these, 391 were ridged (nonspherical) and 134, nonridged (spherical). These figures fit very closely to the 3: 1 Mendelian proportion, with an X^2 value of 0.0768 and a probability of 87.73 per cent.

Normal fruit shape appeared to be dominant over the fasciated in the cross between the Native and Susong Kalabaw, whereas the ridged-fruit shape was dominant over nonridged in the cross between the Native and Kamatis na Ligaw.

Table 5 shows the F_2 segregation of fruit locules in the cross between the Native and Susong Kalabaw, with its chi-square test. There were 381 many-loculed (>2) 129 two-loculed (<2) fruits of the 510 fruits studied. The chi-square test of segregation given in the same table shows that the 3: 1 inheritance ratio is a close fit, with an X^2 value of 0.02354 and a probability of 93.04 per cent.

Of the 525 (Native $\times$ Kamatis na Ligaw) F_2 fruits examined, 390 were many-loculed and 135, two-loculed. These figures fit into a 3: 1 ratio, with an X^2 value of 0.14208 and giving a probability of 81.21 per cent (table 6).

The many-loculed fruits are apparently dominant in the F_2 hybrid types. The Native tomato is a many-loculed fruit. This proves that the gene for fruit locule in the female Native parent has an immediate effect on the ensuing phenotypes.

Table 7 shows the F_2 segregation of fruit size and weight of the two hybrid types. The polar and equatorial diameters and the weight segregated in all gradations with a tendency towards the intermediate size and weight. Similar findings on the mode of inheritance in fruit size were reported by Larson and Currence (1944), Helper (1929), and Powers (1941). Hackbarth

(1940) showed that fruit size is the most difficult goal to attain, since the small size of the parent species appeared to dominate the crosses. All the characters tested for closeness of fit by the chi-square, namely, plant habit, fruit shape, and fruit locules, were found to have very close fitting for a 3 : 1 Mendelian ratio of inheritance, seeming to indicate that inheritance of plant habit, fruit shape, and fruit locules is dependent upon a single gene or factor difference and segregated according to the typical Mendelian monohybrid phenotypic ratio. On the other hand, fruit size, like all other characters of similar category on size inheritance, showed all gradations in the F_2 segregating generation which were too complicated to classify into definite size classes. Because of this complex segregation, it may be assumed that the genes involved in fruit size are numerous. No attempt was therefore made to indicate its inheritance factorially.

PESTS AND DISEASES

Epilachna philippinensis Dieke badly attacked the Native and the (Native × Susong Kalabaw) F_2 plants during the flowering and fruiting stages. The leaves were skeletonized and the bark of the stem and branches was chewed off. The larval stage of the insect was found to be the most destructive period. The adults, eggs, and larvae were picked by hand and destroyed. Susong Kalabaw was not much affected by this pest, while Kamatis na Ligaw and the (Native × Kamatis na Ligaw) F_2 plants were hardly affected.

The garden lot previously used by Capinpin and Sison (1947) was infested with the solanaceous wilt bacteria, *Pseudomonas solanacearum* Erw. Smith. The parents, Susong Kalaw and the Native, were attacked the most by the bacteria. The two hybrids were also attacked severely. Kamatis na Ligaw was the most resistant, with only two cases of infection and death to the plants. In this experiment, however, Kamatis na Ligaw and the two hybrids were the most resistant to the wilt disease.

Cracking of the fruit was occasionally observed. This phenomenon was observed after hot dry days following a heavy rain. Many fruits of the Native and the hybrids were damaged considerably. The Kamatis na Ligaw fruits were not affected by cracking, but the Susong Kalabaw fruits were slightly affected.

According to Uichanco (1915), fruit cracking "is not caused by any organism; but is rather a physiological derangement. It is caused by the existence of conditions favorable to root absorption while there is present a factor which hinders the growth of the fruit skin."

SUMMARY AND CONCLUSIONS

1. The percentage of germination of the F_2 hybrid seeds was higher than that of the parents, with the exception of Kamatis na Ligaw, which had the highest percentage.

2. The F_2 hybrid types flowered, fruited, and matured earlier than the parents, with the exception of Kamatis na Ligaw, which had practically the same periods as the hybrid types.

3. Each of the hybrids produced considerably more fruit than the Native, although still fewer than the male parent.

4. The Native and Susong Kalabaw plants were attacked the most by *Epilachna philippinensis* Dieke and by brown rot or solanaceous wilt, caused by *Pseudomonas solanacearum* Erw. Smith. The hybrids were also affected severely. The parent, Kamatis na Ligaw, was apparently resistant to the solanaceous wilt.

5. Mendelian inheritance was manifested in the F_2 segregation in plant and fruit characters as follows:

a. The plant population of the hybrid (Native $\times$ Susong Kalabaw) F_2 segregated into tall and branchy. The tall plants were dominant, indicating that the gene for tallness in the pistillate Native parent showed its effect in the ensuing phenotypes. Plant habit was a monofactorial unit character which segregated into a 3: 1 monohybrid ratio of tall to branchy.

b. Spreading growth habit was apparently dominant over the less spreading in the segregating-generation cross between Native and Kamatis na Ligaw. The 3 : 1 monohybrid ratio was found to fit in the segregating F_2 generation.

c. The hybrid (Native $\times$ Susong Kalabaw) F_2 segregated into the 3: 1 monohybrid Mendelian ratio of normal to fasciated.

d. The fruit population of the hybrid (Native $\times$ Kamatis na Ligaw) F_2 segregated into three ridged to one nonridged, a ratio suggestive of monohybrid inheritance.

e. The many-loculed character in the two hybrids was dominant over the two-loculed, giving a 3: 1 Mendelian monohybrid ratio.

f. There was a complex unit of inheritance for fruit size and weight of the given hybrid types, with the result that the F_2 populations were found segregating in all gradations.

6. Desirable characters found incorporated in the genotypes of the F_2 segregating hybrids of the cross between the Native and the Susong Kalabaw were early flowering, early fruiting, early maturing, greater number of fruit, normal fruit shape, and many-loculed fruits. Of the cross between the Native and Kamatis na Ligaw, the desirable characters were early flowering, early fruiting, early maturing, spreading growth habit, greater number of fruit, many-loculed fruits, and resistance to pests and diseases.

7. Of the hybrid populations, the (Native $\times$ Susong Kalabaw) F_2 segregates showed more desirable combinations of plant and fruit characters in their genotypic constitution, which upon further test and selection may lead to isolation of homozygous genotypes and true breeding lines.

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TABLE 1

F_2 segregation of plant habits of a cross between the Native and Susong Kalabaw

TYPE OF PROGENY			TALL	BRANCHY
(Native x Susong Kalabaw) F_2				
Monogenic	3 : 1	Observed	77	25
		Expected	76.50	25.50
			X^2 = 0.01306	P = 94.09%
Digenic	9 : 7	Observed	77	25
		Expected	57.37	44.62
			X^2 = 15.2895	P = 1%
Trigenic	37 : 27	Observed	77	25
		Expected	58.83	42.93
			X^2 = 13.0539	P = 1%

TABLE 2

F_2 segregation of plant habit of a cross between the Native and Kamatis na Ligaw

TYPE OF PROGENY			SPREADING (BUSHY)	LESS SPREADING (NOT BUSHY)
(Native × Kamatis na Ligaw) F_2				
Monogenic	3 : 1	Observed	77	28
		Expected	78.75	26.25
			X^2 = 0.1554	P = 79.89%
Digenic	9 : 7	Observed	77	28
		Expected	59.04	45.92
			X^2 = 12.3998	P = 1%
Trigenic	37 : 27	Observed	77	28
		Expected	60.70	44.30
			X^2 = 10.3539	P = 1%

TABLE 3

F_2 segregation of fruit shape of a cross between the Native and Susong Kalabaw

TYPE OF PROGENY			NORMAL (GENERALLY SPHERICAL)	FASCIATED (NONSPHERICAL)
(Native × Susong Kalabaw)		F_2		
Monogenic	3 : 1	Observed	383	127
		Expected	382.50	127.50
			$X^2 = 0.002513$	P = 96.50%
Digenic	9 : 7	Observed	383	127
		Expected	286.83	223.09
			$X^2 = 73.51227$	P = 1%
Trigenic	37 : 27	Observed	383	127
		Expected	294.84	215.15
			$X^2 = 62.32572$	P = 1%

TABLE 4

F_2 segregation of fruit shape of a cross between the Native and Kamatis na Ligaw

TYPE OF PROGENY		RIDGED (IRREGULARLY COMPRESSED)	NONRIDGED (SPHERICAL)
(Native × Kamatis na Ligaw) F_2			
Monogenic 3 : 1	Observed	391	134
	Expected	393.75	131.25
		X^2 = 0.0768	P = 87.73%
Digenic 9 : 7	Observed	391	134
	Expected	295.29	229.67
		X^2 = 70.795127	P = 1%
Trigenic 37 : 27	Observed	391	134
	Expected	303.51	221.48
		X^2 = 59.58233	P = 1%

TABLE 5

F_2 segregation of fruit locules of a cross between the Native and Susong Kalabaw

TYPE OF PROGENY			MANY-LOCULED (> 2)	TWO-LOQULED (<2)
(Native × Susong Kalabaw) F_2				
Monogenic	3 : 1	Observed	381	129
		Expected	382.50	127.50
			X^2 = 0.02354	P = 93.04%
Digenic	9 : 7	Observed	381	129
		Expected	286.83	223.09
			X^2 = 69.48428	P = 1%
Trigenic	37 : 27	Observed	381	129
		Expected	294.84	215.15
			X^2 = 59.53807	P = 1%

TABLE 6

F_2 segregation of fruit locules of a cross between the Native and Kamatis na Ligaw

TYPE OF PROGENY			MANY-LOCULED (> 2)	TWO-LOCULED (< 2)
(Native × Kamatis na Ligaw) F_2				
Monogenic	3 : 1	Observed	390	135
		Expected	393.73	131.25
			X^2 = 0.14208	P = 81.21%
Digenic	9 : 7	Observed	390	135
		Expected	295.29	229.67
			X^2 = 69.32333	P = 1%
Trigenic	37 : 27	Observed	390	135
		Expected	303.51	221.48
			X^2 = 59.22668	P = 1%

TABLE 7

F_2 segregation of fruit weights and sizes in the two hybrids

TYPES	WEIGHT IN GRAMS		SIZE IN CENTIMETERS			
	Weight	No. of fruit	Polar diameter	No. of fruit	Equatorial diameter	No. of fruit
(Native × Susong Kalabaw) F_2	9 - 18	240	2.0 - 2.4	46	2.0 - 2.7	80
	19 - 28	210	2.5 - 2.9	313	2.8 - 3.5	338
	29 - 38	47	3.0 - 3.4	138	3.6 - 4.3	86
	39 - 48	5	3.5 - 9.0	13	4.4 - 5.1	6
(Native × Kamatis na Ligaw) F_2	3.8 - 9.8	319	1.0 - 1.5	147	1.5 - 2.5	390
	8.9 - 13.9	164	1.6 - 2.1	345	2.6 - 3.6	123
	14.0 - 19.0	29	2.2 - 2.7	28	3.7 - 4.7	8
	19.1 - 24.1	13	2.8 - 3.2	5	4.8 - 5.8	4

AUTOSEXED CHICKS FROM LOS BAÑOS CANTONESE AND BARRED PLYMOUTH ROCK FOWLS[1]

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Autosexed chicks are those chicks with a particular color inheritance that will allow the easy segregation of male and female at the time of hatching. The production of such chicks would make possible the immediate removal of male chicks at hatching time and thus eliminate a factor that increases the cost of production of pullets, which are the only ones concerned in egg production. This rapid and perfect method of sex identification would facilitate studies in nutritional requirements and physiology of chicks of different sexes. It would also allow merchandizing chicks accurately according to sex, which is not possible with the so-called Japanese, or cloacal, method of sex separation, a method of sexing chicks that requires considerable training and skill.

The phenomenon of autosexing was first described and published by Punnett and Pease in 1930, and since then a number of autosexing varieties have been developed by both English and European workers. The first autosexing breed was known as the Cambar. This breed had been developed in England out of matings between Barred Plymouth Rocks and Gold Campines. The male of this particular breed has a pale "blotchy" down color, whereas the female has down characteristics similar to those of Gold Campine chicks. The Cambar is white-skinned and is relatively poor in egg production. In Europe, one autosexing Leghorn variety commonly called Legbar was produced by superimposing barring on the feather pattern of the Light Brown Leghorn (Jaap, 1940).

Jerome (1939) observed that the difference in barring between the feathers of the male and the female Barred Plymouth Rock is reflected in the down color of the chicks by the white spot on the occipital region. He reported an accuracy of 98 per cent in distinguishing the sex of 300 Barred Plymouth Rock chicks. According to him, the females have a more intense black pigmentation and smaller occipital spots than the males. Some authors, however, attribute Jerome's success in distinguishing the sex to his knowledge of sex-limited difference in the shape of the spot (Jaap, 1940; Lamoreux, 1941).

[1]Experiment Station Contribution No. 1494. This paper is a part of the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, University of the Philippines, 1945.

The Oklabar is one of the first autosexing breeds developed in the United States (Jaap, 1940). This is a large-bodied breed in which White Plymouth Rock was used instead of Barred Plymouth Rock because in this particular strain, hidden in the absence of color, were stripped down color and barring inheritance which had been unmasked previously by crossbreeding. To improve the breed, two desirable characteristics, table quality and absence of "bare backs" in broilers, are being introduced in the Oklabar by using a strain of Black Cornish possessing these two desirable characteristics. This may destroy the automatic sexing principles for a few generations, but to establish uniformity in feathering, body shape, egg production, and other economic characteristics will also require several years.

Because Cambar is white-skinned and relatively poor in egg production, Lamoreux (1941) developed a more productive breed with yellow skin, which he reported was preferred in the American market. This breed, now popularly known as Ancobar, was produced from an original mating of Barred Plymouth Rock and Ancona. In fact, all autosexing breeds that have been reported in literature have utilized the sex-dichromatism resulting from the use of sex-linked genes for barring.

In order to determine the possible use of Cantonese when crossed with Barred Plymouth Rock fowls in the production of autosexed chicks, this study was undertaken. The experiments were conducted from April to December, 1944.

PROCEDURE

Twelve Los Baños Cantonese hens were mated to a Barred Plymouth Rock rooster, and twelve Barred Plymouth Rock hens to a Los Baños Cantonese rooster. All hatchable eggs produced from both matings were incubated and the chicks classified according to the size of head spots, regardles of their shape. Distinction was accomplished by roughly dividing the chicks into four major phenotypic divisions as follows:

Group 1. Large spot. This group included those chicks whose head spots covered the entire dorsal part of the head.

Group 2. Medium spot. This group included those chicks whose head spots occupied only half of the dorsal area of the head.

Group 3. Small spot. This group included chicks whose head spots were less than half the dorsal area of the head.

Group 4. No spot.

Most of the chicks were raised to maturity, when their sexes showed definitely. Those that died during their early period of life were autopsied to determine the sex by an examination of the repro-

ductive organs. In the later trials, the chicks were killed at hatch and examined in the same way as the chicks that had died earlier.

As soon as the crossbreeds could breed successfully, the best rooster was back-crossed with another set of Los Baños Cantonese hens. The size of head spots in the case of chicks possessing that characteristic was classified large when the spot occupied half of the entire dorsal area of the head, and small when the head spot was less than one half of the dorsal area of the head. In the case of entirely black chicks, the difference in the intensity of pigmentation was made the distinguishing factor.

RESULTS AND DISCUSSION

Observations on the chicks produced by reciprocal matings of Barred Plymouth Rock and Los Baños Cantonese. The general down color of the chicks was observed to be black and the most conspicuous characteristic feature was the presence or absence of white head spots. When present, the size and shape of the head spots varied. When the Barred Playmouth Rock male was mated to Los Baños Cantonese females, all the chicks produced had head spots, while of the chicks produced from matings between the Los Baños Cantonese male and Barred Plymouth Rock females, only about half had white spots on the head, and the rest were entirely black. The chicks with head spots were barred at maturity, but the black chicks remained black. Most of the black pullets, however, had dark golden buff or yellowish feathers on the neck. It was also observed that the male barred crossbreeds were very much lighter in color than the female barred crossbreeds, and that these females were very much similar to the female Barred Plymouth Rocks. The male crossbreeds, however, were found to be much lighter than the male Barred Plymouth Rock. Theoretically, the male Barred Plymouth Rock should be darker because the background of the bars is black. In the cross, however, the background was probably a combination of black and yellow or golden buff, which is predominant in the neck and saddle feathers of the barred crossbreeds. Thus, the cross breeds were lighter.

Relation between the size of head spots and the sex of chicks produced by Barred Plymouth Rock male mated to Los Baños Cantonese female. All of the 163 chicks produced when the Barred Plymouth Rock male was mated to Los Baños Cantonese females were observed to have head spots. These head spots were classified into small, medium, and large, depending upon their size. In accordance with the claim of Jerome (1939) that the chicks with small head spots are female in the case of pure Barred Plymouth Rock chicks, in these observations the chicks with small head spots were classified as females, those with large head spots as males, and those with medium-sized head spots either as males or females.

In so doing, an error of 50 per cent was observed to have been committed in classifying the chicks with small head spots as females, and 34.6 per cent, in classifying the chicks with large head spots as males. When the chicks with medium head spots were classified as males, an error of 46.6 was obtained, but when they were classified as females, the error was 53.4 per cent. In the test of Quinn and Knox (1939) on the feasibility of segregating the sexes in the baby chicks produced from a cross of Barred Plymouth Rock male and Rhode Island Red female, a cross popular among broiler raisers, they reported an accuracy of 64.90 per cent out of 754 chicks observed. Their results were a little better than those found in this study, a difference that may be due in part to the large number of chicks they observed.

Relation between the presence and absence of head spots and the sex of the chicks in the Los Baños Cantonese male × Barred Plymouth Rock female mating. Out of 171 chicks produced when the Los Baños Cantonese male was mated to Barred Plymouth Rock females, 89 had head spots of which 35 were small, 37 medium, and 17 large. The rest of the chicks were without head spots. All chicks with head spots of any size were observed to be males, and those without, females. Sex identification in baby chicks of this particular cross is, therefore, perfect. These chicks, however, do not autosex because this crossbreed is not yet a fixed breed. These results are similar to those obtained in the mating of Rhode Island Red male with Barred Plymouth Rock female, as reported by Jull (1940).

Relation between the color of the down and the size of head spots to the sex of the first backcross. Observations made on the chicks produced when a Barred Plymouth Rock and Los Baños Cantonese male crossbreed was mated to Los Baños Cantonese hens showed that the color of the down and the size of the head spots could not be used to identify the sexes of the baby chicks. In the first backcross, in both cases, the errors observed were quite high. The results might be different if a greater number of chicks are observed and backcrossing is repeated for some more generations and accompanied by rigid selection. In such case, an autosexing breed from the original cross of Barred Plymouth and Los Baños Cantonese may be possible. The crossbreeds produced in this first backcross mating were, however, unfortunately lost during the last days of the recent war.

SUMMARY AND CONCLUSIONS

1. The most conspicuous characteristic feature in the crossbreeds produced from reciprocal matings of Barred Plymouth Rock and Los Baños Cantonese is the presence or absence of white head spots and the size of head spots, if present, in the chicks.

2. The size of head spots cannot be used to identify the sexes of baby chicks produced from a Barred Plymouth Rock male mated to a Los Baños Cantonese female.

3. The presence of head spots, regardless of the size, in the chicks produced from a Los Baños Cantonese male mated to a Barred Plymouth Rock female marked definitely the chicks as male, and those without head spots, as female.

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INTINTIW AND SINARIAYA AS SECONDARY CROPS IN SUCCESSION TO A PRIMARY RICE CROP[1]

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Early maturing varieties of rice may be grown successfully as secondary crops in succession to the regular or primary rice crop. The secondary crop is planted from May to June and harvested in September to October. The primary crop is planted in the seedbed from July to August, transplanted in September to October, and harvested in February to March.

The lowland rice field of the College of Agriculture at Los Baños, Laguna is dependent upon rain for irrigation; hence, for a long time, only one crop of rice a year was raised. The performance of Sinariaya, one of the early maturing varieties grown on the neighboring farms and reported to mature in 95 to 100 days from broadcasting in the field, and Inintiw as secondary crops in succession to a primary rice crop was determined in an experiment conducted from May to September, 1944, in the Experiment Station field of the College of Agriculture.

Review of literature

Borja and Torres (1930) reported that Inintiw was commonly planted broadcast in the upland fields of Los Baños. It is a non-bearded variety, straw-colored and elliptical, with white medium hard kernels, and with fair eating quality. This variety matured within 120 days and gave a fair yield.

Camus (1921) reported that Inintiw matured in 123 days and gave a yield of 45.7 cavans a hectare.

EXPERIMENT, RESULTS, AND DISCUSSION

Preparation of the plots

The field used in the experiment was a rectangular piece of land of clay loam soil in the Experiment Station, with an area of 6,000 square meters. It had never been planted to any other crop but rice. After the last crop was harvested in February, 1944, the land was fallowed. Ten plots of 300 square meters each for each variety were arranged at random to allow analysis of variance.

[1] Experiment Station Contribution No. 1495. This paper is based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture in November, 1945.

In the early part of May, 1944, when the first rain fell, the land was plowed once with a Filipino plow. Then the field was left alone for two weeks and was not harrowed until after the seeds had been broadcast on May 29, 1944.

Method of planting and emergence of the seedlings

The seeds of Inintiw were obtained from the Division of Annual Farm Crops, Department of Agronomy, and the seeds of Sinariaya, from Bay, Laguna.

The seeds contained in a small basket were broadcast by hand on May 29, 1944, at the rate of two gantas to a plot, or 66 gantas a hectare. The land was then harrowed to cover the seeds. This high rate of seeding was necessary because the percentage of germination of the seeds was very low, being only about 50 per cent.

Emergence of the broadcast seeds of the two varieties began after eight days; practically all the seeds germinated after the tenth day. Germination was slow because of the long dry spell. Poor germination was exhibited by both varieties. Three days after germination, the plants were more or less uniform in height. Both varieties were pale green at the seedling stage. There were no noticeable differences in height, vigor, and color of leaves of the plants at this stage; however, marked differences in height, color, and growth were observed after several weeks. Sinariaya was paler and shorter than Inintiw, but Inintiw was more vigorous than Sinariaya. The plants of the Sinariaya variety in plots 17, 19, and 20 were distinctly stunted in growth, owing probably to the abundance of weeds.

Height of plants

The plants of the Inintiw variety were more uniform in height than those of the Sinariaya. Inintiw had a mean height of 152.28 centimeters and Sinariaya, 124.18 centimeters, or a difference of 28.10 centimeters. This difference in height of the plants was statistically significant.

Bearing culms

Inintiw had a mean of 4.10 bearing culms to the hill and Sinariaya, a mean of 2.12. Sinariaya appeared to be a much inferior variety than Inintiw in this respect, the latter producing almost twice as many bearing culms per hill as the former. The statistical computation showed that Inintiw had significantly more bearing culms per hill than Sinariaya.

Flowering and maturity periods

Sinariaya flowered, on the average, 92.6 days after broadcasting while Inintiw took an average of 95.7 days to flower. The difference of 3.1 days, however, was insignificant. Sinariaya matured on an average of 113.1 days and Inintiw, 117 days after the seeds were broadcast. The difference of 3.9 days, however, was also insignificant. In this experiment Inintiw matured earlier than that reported by Borja (1930) and Camus (1921).

Lodging and pests and diseases

Sinariaya did not lodge except in plots 13, 17, 19, and 20, where some of the plants lodged at the time of harvest. On the other hand, the plants in all the plots of Inintiw lodged at the time of harvest, when the plants were approaching maturity, owing largely to the increased weight of the grains in the panicles.

Some pests were observed to attack the rice plants of both varieties. The rice bug *Leptocorisa acuta* Thunberg (Coreidae) was responsible for some empty grains in some panicles. From the time the grains were at the "dough" stage till they matured, the rice attracted the rice weaver, which fed on the grains. The damage caused by the rice weaver, however, was considerably minimized by driving the birds away.

Some grains were infected with the false smut caused by *Ustilaginoidea virens* (Cke.) Tak., but the damage was insignificant.

Yield and milling percentage

Table 1 shows the comparative yield of the two varieties. Inintiw gave a mean yield of 53.03 kilograms per 300 square meters and Sinariaya, 34.93 kilograms. The difference of 18.10 kilograms was significant. Based on 44 kilograms per cavan, Inintiw gave a computed yield of 20.63 cavans per hectare, and Sinariaya, 14.45 cavans. The comparison showed a difference of 6.18 cavans per hectare in favor of Inintiw.

Inintiw gave a higher yield than Sinariaya, perhaps largely because of the ability of the former to produce more bearing culms to the hill than the latter. Inintiw lodged at maturity, indicating that it produced heavier panicles than Sinariaya.

The yield of Inintiw in the present study was much lower than the yield of 45.7 cavans per hectare reported by Camus (1921), owing doubtless to dissimilarity in soil and climatic conditions under which the crops were grown.

It was found that Inintiw had a milling percentage of 66 and Sinariaya, 67, or a difference of only one per cent.

SUMMARY

1. The plants of Inintiw were more uniform in height than those of Sinariaya. Inintiw, with a mean height of 152.28 centimeters, was significantly taller than Sinariaya, with its mean height of 124.18 centimeters.

2. Inintiw had more bearing culms to the hill than Sinariaya.

3. Inintiw flowered on an average of 95.7 days and matured 117 days after broadcasting, whereas Sinariaya flowered on an average of 92.6 days and matured in 113.1 days.

4. Inintiw lodged more than Sinariaya.

5. Both varieties were attacked by some pests and diseases, which, however, did very slight damage.

6. Inintiw had a milling percentage of 66 and Sinariaya, 67.

7. Inintiw gave a significantly higher yield than Sinariaya.

These results suggest that if a secondary rice crop is to be grown in the College rice fields, Inintiw should be used in preference to Sinariaya.

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TABLE 1

Comparative yields in kilograms

PLOTS	VARIETIES		DIFFERENCE (I-S)
	Inintiw	Sinariaya	
1	87.98	27.60	60.38
2	52.80	22.80	30.00
3	42.24	34.51	7.73
4	79.27	29.93	49.34
5	68.64	37.32	31.32
6	45.76	22.88	22.88
7	39.72	56.28	- 16.56
8	34.94	38.72	- 3.78
9	42.24	36.96	5.28
10	36.72	42.24	- 5.52
Total	530.31	349.24	181.07
Mean	53.03	34.93	18.10

$$Sd = \sqrt{\frac{2V}{N}} = \sqrt{\frac{2 \times 285.73}{10}} = 7.59$$

$$d = 18.10; \quad t = \frac{d}{Sd} = \frac{18.10}{7.59} = 2.490 \text{ (significant)}$$

$$df = 18; \quad \begin{matrix} & 5\% & 1\% \\ t = & 2.101 & 2.878 \end{matrix}$$

THE EFFECT OF SOIL REACTION (pH) ON THE GROWTH OF PE-TSAI PLANTS AND ON THEIR NITROGEN, CALCIUM, AND PHOSPHORUS CONTENT[1]

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Of the Department of Soils

Much has been done elsewhere on the response of plants to soil reaction although contribution along this line in the Philippines is very limited. Truog (1918), Crist (1925), Magistad (1925), McLean and Gilbert (1927), Wiggin and Gourley (1931), Wilson (1932), Hester and Shelton (1934), Shear (1938), and Narangajavana (1942)[2] show that soil reaction takes an important part in scientific agriculture. Only Narangajavana did his work in the Philippines.

The present study was made in the Department of Soils of the College from November, 1940, to September, 1942.

MATERIALS AND METHODS

Soil. The Lipa clay loam collected from a backyard in the Coconut Grove, Los Baños, Laguna and used in this study was first thoroughly dried, pulverized, and mixed. It had a pH value of 7.0. The physical and chemical properties of the soil were as follows: water-holding capacity, 68.59 per cent; colloid content, 50.79 per cent; organic matter, 1.2 per cent; plant foods held in reserve (soluble in 10 per cent HCl) SiO_2, 0.29 per cent; sesquioxides, 22.63 per cent; CaO, 0.78 per cent; MgO, 0.64 per cent; K_2O, 0.13 per cent; Na_2O, 0.16 per cent; SO_3, 0.15 per cent; P_2O_5, 0.17 per cent; and N, 0.18 per cent.

The plants used. The seeds of pe-tsai, *Brassica pekinensis* Rupr., were sown in a seedbox, and two weeks after germination the seedlings were transplanted to the different lots having pH values from 3.7 to 8.6.

Soil containers. Seventy petroleum cans cut in halves and painted with dehydrated coal tar were each filled with 8 kilograms of soil. They were divided into 7 lots of 10 replications each. The

[1] Experiment Station Contribution No. 1496, presented by the senior author as thesis for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1943. Prepared in the Department of Soils under the direction of the junior author.

[2] NARANGAJAVANA, C. 1942. Growth and yield of soybean plants on Lipa clay loam with or without fertilizers and with adjusted pH values. (Thesis presented for graduation with the degree of Bachelor Science in Agriculture, 1942. Unpublished.)

reactions of the soil lower than pH 7.0 were adjusted by the addition of a normal solution of sulfuric acid, and those higher than pH 7.0, by the addition of milk of lime.

Determination of the pH of the soil and of the chemical content of the plants. The pH values of the soil were determined colorimetrically in accordance with the method of Spurway (1938). The methods for the determination of the phosphoric acid and calcium content of the pe-tsai plants were similar to those of Merkle (1940). Nitrogen was determined according to the technique described by the Association of Official Agricultural Chemists (1935).

Transplanting. Two-week-old pe-tsai seedlings were transplanted on September 23, 1941, for the first planting and on October 28, 1941, for the second.

Two vigorous seedlings were planted in each pot at the start, but when the seedlings had regained their original vigor, only one vigorous plant was allowed to grow until harvest.

Care of the plants. The plants were cultivated and watered whenever necessary. Insect pests were destroyed and weeds were pulled out as they appeared.

Harvesting. At maturity the portion of the plant above the ground was cut and weighed. The plants were allowed to dry in the air, placed in an electric oven at 100° to 105° C. until their weights were constant, and later used in the determination of phosphorus, calcium, and nitrogen content.

RESULTS

Unlike the pe-tsai plants transplanted in soil with pH values ranging from 4.2 to 8.6, the plants in lots with pH values of 3.5 to 3.8 and the majority of those in the lot with pH 4.0 failed to show appreciable signs of recovery. The effects of soil acidity on the plants were apparent about one week after the seedlings were transplanted. The plants became pale, chlorotic, and stunted in growth. Some of the leaves wilted, dried gradually, and finally dropped off. The plants did not increase in height, their leaves gradually wilted, and finally the plants died before they matured.

The plants in the lots with pH values of from 4.2 to 8.6 recovered gradually and showed better appearance, growth, and vigor than those which were transplanted in lots with pH values from 3.5 to 3.8. It was also noted that in lots with pH values ranging from 4.2 to 5.0, the plants had stunted growth and were generally smaller than those grown in lots with pH values ranging from 5.9 to 8.6. Better growth than the rest was shown by the plants in pH 8.2 and 8.4.

It was further noted that the plants in the second planting (October 28, 1941) were more vigorous and bigger than those in the first planting (September 23, 1941). This was attributed partly to the less amount of rainfall from October 28, 1941, to December 11, 1941, than from September 23, 1941, to November 5, 1941.

There was a change in the soil reaction ranging from pH 0.1 to 0.6 after the cropping, and the greater change was observed on the acidic side rather than on the alkaline.

DISCUSSION OF RESULTS

In table 1 it is evident that the fresh weights of the pe-tsai plants in the first planting were influenced by the soil reaction. The variation brought forth the fact that under the condition of the experiment, soil reaction was a limiting factor in the cultivation of pe-tsai. It may also be seen in table 1 that the mean weights of pe-tsai ranged from 14.202 grams at pH 4.8 to 25.692 grams at pH 8.2. Evaluating and assessing the mean weights in accordance with the least mean difference (5.788), one may infer that the mean values of 25.692 grams, 22.797 grams, 20.000 grams, 19.964 grams, and 19.927 grams, corresponding to pH values of 8.2, 8.0, 8.6, 7.0, and 5.9, respectively, are statistically identical and rank higher than the mean weights of 15.730 grams, 15.048 grams, and 14.202 grams, which correspond to pH values of 4.3, 5.0, and 4.8, respectively.

It is also apparent in table 1 that soil reaction had no marked effect on the percentage of nitrogen, CaO, and P_2O_5 in pe-tsai plants.

With regard to the weights of the plants in the second planting, it is obvious that, as a whole, the fresh weights are similar to those in the first planting. Quantitatively, however, the weights of the plants in the second planting were higher than those in the first, perhaps owing to an abundance of rainfall. In the first planting, the total amount of rainfall from the date of planting (September 23, 1941) to harvesting (November 4, 1941) was 488.96 mm., or a daily mean rainfall of 11.11 mm.; whereas, in the second planting, the total amount of rainfall from the date of planting (October 28, 1941) to harvesting (December 11, 1941) was 153.36 mm., or a daily mean rainfall of 3.40 mm. As in the first planting, the highest weight was attained by the pe-tsai plants at pH values above 8.0; whereas the plants in the lots with pH values of 3.5 and 3.8 failed to grow to maturity, showing that the high acidity was toxic to the pe-tsai plants.

The percentage of nitrogen, CaO, and P_2O_5 in the pe-tsai plants appeared not to have been affected by the amount of rainfall.

SUMMARY

1. The pe-tsai plants had a wide pH range of tolerance, but high acidity was detrimental to their growth. Those that were grown in lots with pH values of 3.5 to 3.8 died before maturity. Eight out of the 10 plants in the lot with a pH value of 4.0 did not grow to maturity. Normal growth was shown by the pe-tsai plants in media with pH values ranging from 4.2 to 8.6.

2. Better growth was observed among pe-tsai plants grown in soils with pH values ranging from 5.9 to 8.6. A soil that was slightly alkaline, however, was preferable.

3. Soil reaction had an insignificant effect on the percentage of nitrogen, CaO, and P_2O_5 in pe-tsai plants.

4. Although the amount of rainfall affected the growth of pe-tsai plants, it did not influence materially the amount of nitrogen, CaO, and P_2O_5 in them.

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per cent of nitrogen, CaO, and P_2O_5 in pe-tsai plants

TREATMENTS											
pH		pH		pH		pH		pH		L. M. D.[c]	
5.9 F.P.	5.0 S.P.	7.0 F.P.	6.6 S.P.	8.0 F.P.	7.8 S.P.	8.2 F.P.	8.2 S.P.	8.6 F.P.	8.4 S.P.	F.P.	S.P.
19.927	26.250	19.964	37.688	22.797	36.022	25.692	40.144	20.000	48.940	5.788	7.786
2.041	2.045	2.139	2.036	2.123	2.122	2.088	2.067	2.077	2.043		
2.593	2.662	2.806	2.523	2.813	2.648	2.699	2.656	2.903	2.658		
1.425	1.392	1.514	1.517	1.396	1.461	1.370	1.457	1.414	1.416		

EFFECTS OF 2, 4-D ON SOME COMMON PLANTS[1]

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Of the Department of Agricultural Botany

The object of this study was to determine the effects of 2, 4-D on some common plants, especially garden or farm weeds. According to its manufacturers, the active ingredient is 60 per cent by weight of 2, 4-dichlorophenoxyacetic acid.

This weed killer is believed to be a "herbicidal hormone composition which when applied to and taken in by certain plants in the proper proportion causes distortion of growth and gradual death." The makers claim that it "contains spreading and penetrating agents to facilitate penetration of the hormone through the plant tissues and into the 'sap channels' for distribution throughout the plants."

The study was carried out in the experimental yard of the Department of Agricultural Botany, which became overgrown with weeds owing to neglect caused by the recent war. A solution of the weed killer was sprayed on the plants on November 21, 1946.

MATERIALS, METHODS, AND RESULTS

As recommended by the manufacturers, the spray solution of this weed killer was prepared at the rate of 2.3 grams of 2, 4-D powder to make a liter of solution. The solution was applied at the rate of "1 gallon per square foot" of area. Upon computation, this rate of application was found to be 9.36 kgm. of the powder or mixture to the hectare. In this study only one liter of solution was prepared, with ordinary tap water as solvent. With the use of a Universal Sprayer, the solution was liberally sprayed on the leaves of the plants on a bright sunny afternoon. The results from the initial spraying made on November 21, 1946, are tabulated as follows:

	1946			
PLANTS SPRAYED	NOVEMBER 22	NOVEMBER 23	NOVEMBER 27	DECEMBER 7
Amaranthus spinosus	branches drooping	still drooping	stem and leaves yellowish	leaves dried
Manihot utilissima	leaf blades upside down	same as before, younger leaves wilting	younger leaves curved; other leaves turgid	plants still alive but younger leaves wilted
Momordica charantia	some leaves turgid but inclined	shoot drooping	shoot turgid again	fully recovered

[1]Experiment Station Contribution No. 1497. Thanks are due my class in plant nutrition for help in carrying out the experiment.

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PLANTS SPRAYED	NOVEMBER 22	NOVEMBER 23	NOVEMBER 27	DECEMBER 7
Zea mays	no effect	none	none	normal
Synedrella nodiflora	leaves flaccid, hanging downward	same position, younger leaves curled downward	leaves green and turgid but upside down	dead
Imperata cylindrica	no effect	none	none	normal
Oryza sativa	no effect	none	none	normal
Manihot utilissima (a branch sprayed)	younger leaves drooping; older leaves upside down	leaves flaccid	willting	(accidentaly cut)
Phaseolus lunatus	younger part of shoots flaccid	younger leaves wilting curled and some leaves normal	many leaves yellowish and drying	entire plants dry
Paspalum conjugatum	no effect	none	none	normal
Imperata cylindrica	no effect	none	none	normal
Mimosa invisa	younger leaves curled; older leaves normal	most of younger leaves wilting	most leaves recovering turgidity; some leaves dried and fallen off	plants recovering
Elephantopus scaber	younger leaves wilting a little	same as before	normal again	recovered turgidity
Amaranthus spinosus	shoot lost turgidity	same as before	shoot turgid again	recovered
Canna indica	broad leaves slightly turgid	same as before	no effect; leaves with whitish coating of chemicals	normal
Cyperus rotundus	no effect	none	none	normal

DISCUSSION

As may be seen in the foregoing tabulation, sixteen groups or lots of plants were sprayed with the solution of the weed killer. The sprayed plants consisted of thirteen species belonging to eight families of spermatophytes, which, being very common in the Philippines and of high economic value, were purposely selected for this study.

Species of Gramineae. According to the literature furnished by the manufacturers, this herbicidal hormone weed killer has no ill effects upon the members of the grass family. Evidently this is true, for not one of the four species of the family studied, *Imperata cylindrica, Oryza sativa, Paspalum conjugatum,* and *Zea mays,* was adversely affected by the solution.

Cyperus rotundus. Muthá (*Cyperus rotundus*), a sedge and another very common garden and farm weed, was also sprayed with the solution of the weed killer. Like cogon and the other species of the grass family studied, muthá (Cyperaceae) was not adversely affected by the weed killer.

Amaranthus spinosus. Two lots of kolites (*Amaranthus spinosus*) of the family Amaranthaceae were sprayed with the solution. As recorded in the foregoing tabulation, the plants in both lots soon showed the effects of the treatment. The shoots lost turgescence and the young branches began to droop. On the sixth day, the leaves of the plants in one lot turned yellowish, and ten days later all the leaves became dry. On the other hand, the plants in the second lot, although at first showing the ill effects of the solution, became turgid again six days after the treatment.

Canna indica. Two hills of bandera española, or tikastikas as this plant is called in Tagalog, were sprayed with a solution of the weed killer. The dose was strong, as shown by the white powdery deposits on the surface of the leaves; nevertheless, the spray apparently produced no harmful effects upon the plant.

Elephantopus scaber. This weed, which possesses spreading leaves almost touching the ground and with a rather well-developed tap root, was also sprayed with the weed killer solution. Although the leaves seemed to wilt after one day, no ill effect was finally produced upon the plants. This resistance of the weed to 2, 4-D is quite unfortunate, as this weed frequently appears even in well-kept lawns in the Philippines, and uprooting it would mar the beauty of the lawn.

Manihot utilissima. The wilting effect of the weed killer on the leaves of this plant became quite apparent one day after the treatment. The plants remained wilted throughout the observation without even regaining the state of turgescence of the shoot. At first glance, this finding seems to argue against general use of

the weed killer. Fortunately, it is not so bad as might be pictured because the cassava plant, although grown in a field which might be overgrown with weeds, grows to a considerable height so that when the weeds are sprayed with the solution, there is very little chance for it to fall on the leaves of the cassava plant. Incidentally, it should be admitted that no test has as yet been made to determine whether or not the weed killer has any harmful effects upon the roots of this plant.

Mimosa invisa. As is well known, this is a very close cousin of *Mimosa pudica,* the famous makahiya, or sensitive plant. When the spraying tests were made, *Mimosa invisa,* which got into the Philippines by accident and grows much more luxuriantly than the makahiya, happened to be well spread on the experimental lot selected; hence, its use. One day after having been sprayed, the younger leaves curled, while the older leaves remained normal. As days went by, the younger leaves began to wilt and quite a number of them fell off. Unfortunately, however, by December 7, or 16 days after the treatment, the plants were seen recovering.

Momordica charantia. Twenty-four hours after being sprayed, some leaves of ampalaya were still turgid but had assumed an inclined position. Later the shoot was seen drooping, and still later, to the surprise of the observers, the plants became rigid and erect again, indicating full recovery. This, in the writer's opinion, is good, as it is not desirable that the ampalaya, a food-producing plant, be killed by the weed killer.

Phaseolus lunatus. The weed killer was fatal to the young patani plants (*Phaseolus lunatus*). A day after the treatment, the younger parts of the shoots wilted. Later the younger leaves curled up and remained wilted, and by the end of the experiment, all the plants of this species had become dry. However, since this is a vine with leaves usually held way above the crowns of the common weeds, there is very little chance, if any, for the spray solution to reach its leaves.

Synedrella nodiflora. The weed killer seems to be effective on this garden weed. The leaves of this plant became flaccid and assumed a hanging position one day after being sprayed with the solution. The plants never regained turgidity and were all found dead by the conclusion of this experiment on December 7, 1946.

SUMMARY AND CONCLUSION

1. Among the seven garden or farm weeds sprayed with 2, 4-D solution at the rate of 2.3 grams of 2, 4-D powder to make a liter of solution, no apparent harmful effect was observed on *Cyperus rotundus, Imperata cylindrica,* and *Paspalum conjugatum. Ele-*

phantopus scaber and *Mimosa invisa* recovered from wilting. *Synedrella nodiflora* was killed outright. One group of *Amaranthus spinosus* was killed, but another group was not.

2. Among the ornamental and food-producing species, no harmful effects whatsoever were observed on *Canna indica, Oryza sativa,* and *Zea mays. Momordica charantia* recovered from the wilting temporarily caused by the weed killer. The 2, 4-D solution was rather harmful to *Manihot utilissima* and fatal to *Phaseolus lunatus.*

3. From the results, it is obvious that this weed killer in the concentration tested cannot kill the five most common and most troublesome garden and farm weeds in the Philippines. Other concentrations may be tried later.

PERFORMANCE OF SERAUP KECHIL 36 AND CARREON RICE VARIETIES UNDER UPLAND CONDITIONS[1]

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The high-yielding quality under College conditions of Seraup Kechil 36, one of the highest yielders among the important varieties tested in the College of Agriculture lowland rice field, may perhaps be attributed partly to its ability to withstand dry conditions. Farmers believe that Seraup Kechil 36 is the rice to grow on the College farm, where the land depends upon rainfall for irrigation water. In an earlier study of Seraup Kechil 36 planted by the "dapog" system, it was found that it matured within 154 days and that it is drought-resistant. This behavior of Seraup Kechil 36 strongly suggested that it might be grown profitably under upland conditions. In order to compare the performance of Seraup Kechil 36 with Carreon, the most important upland variety of rice in the College, a study was made in the College Experiment Station from May, 1943, to December, 1943.

Ariaga[2] found that Carreon bloomed in 103 days and matured in 136 days after the seeds had been drilled in the field. He also found that the control plots gave an average yield of 43.28 $\mp$ 0.485 cavans to the hectare.

Aragon and Cada[3] found that Seraup Kechil 36 bloomed in 126 days and matured in about 169 to 175 days from the seedling period. Under average conditions the yield was 68.63 cavans a hectare.

Calma and Cada[4] reported that of the varieties tested in the College, Seraup Kechil 36 was one of the highest yielders. They found that Seraup Kechil 36 had an average yield of 64.5 cavans a hectare.

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[1] Experiment Station Contribution No. 1498. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1944. Prepared in the Department of Agronomy under the direction of Dr. Valeriano C. Calma.

[2] ARIAGA, JUAN A. The effect upon the yield of upland rice (Carreon variety) of the application of different amounts of Hoz fertilizer. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1941. Unpublished.)

[3] ARAGON, VICENTE B., AND E. CADA. 1939. A preliminary report on the performance of ten rice varieties from the Federated Malay States. Philippine Agriculturist 27: 635-646.

[4] CALMA, VALERIANO C., AND E. CADA. 1941. A comparative test of six varieties of rice. Philippine Agriculturist 30: 548-554.

Hornilla[5] found that the mean number of tillers of Seraup Kechil 36 to the hill in plots planted to seedlings grown by the "dapog" system varied from 8.0 to 14.1, with a mean average of 9.9, whereas those from plants in the wet-bed plots varied from 7.7 to 10.7, with a mean average of 8.9 tillers. He also found that the plants from the ordinary wet-bed plots bloomed in 105 days after transplanting and matured 38 days later, or 174 days after sowing. The plants from the "dapog" seedbed bloomed after 109 days and matured 37 days later, or 154 days after sowing.

EXPERIMENTS, RESULTS, AND DISCUSSION

The varieties of rice used, Seraup Kechil 36 and Carreon, were obtained from the Division of Annual Farm Crops, Department of Agronomy.

The land used, a portion of the upland rice field of the College, had an area of 5,000 square meters of well-drained clay loam soil. It was previously planted to corn. Five plots of 500 square meters each were allotted at random for each of the two varieties.

On May 5, 1943, after the first few days of rain, the field was plowed for the first time and harrowed the following day. On May 17, 1943, the field was again plowed and the clods broken with a Philippine harrow ("kalmot").

After the second harrowing, the rice seeds were broadcast at the rate of 2.6 gantas to a plot, or 52 gantas a hectare. The land was plowed again to cover the seeds. The "kalmot" was used for leveling the ground after the last plowing.

The plots were weeded by hand on June 27 and August 15, 1943.

Two species of birds, the Philippine weaver, "mayang pula" or *Munia atricapilla minuta,* and the Java sparrow, "mayang costa" or *Padda oryzivora* Linn., frequented the field, but the damage done was minimized by driving them away.

The changes in the general appearance of the plants were observed from the germination of the seeds to harvest time.

At maturity, twenty plants from each plot were taken at random and each measured with a meter stick from the base to the tip of the panicle.

The tillering capacity of twenty plants from each plot taken at random was determined by counting the bearing culms.

The dates when the majority of the plants were in bloom were recorded as the time of flowering of the plants of the two varieties.

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[5] HORNILLA, SALVADOR M. The cost of producing rice using the "dapog" and the wet-bed methods of raising seedlings. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1943. Unpublished.)

The dates when the grains were full and hard were considered the dates of maturity. The grains were harvested with a tool locally called "yatab." Three to six people harvested the crop of each plot.

The harvest from each plot was threshed immediately by trampling on the rice on buri mats until all the grains were separated from the panicles. The rice grains were cleaned by winnowing in a shallow basket. The full and the empty grains from each plot of Carreon were weighed on an "Army and Navy" balance before being placed in sacks. Because the grains of Seraup Kechil 36 were very light, the yield of each plot was weighed in a Cenco balance.

Three dried samples of each variety were weighed and milled separately to determine the percentage of milling.

External appearance of the plants. During the early part of the experiment, both varieties had practically the same vegetative vigor. Later, however, Carreon became more vigorous, darker green, and at maturity more uniform in height than Seraup Kechil 36. Furthermore, there was uneven growth of the plants of Seraup Kechil 36, especially those in plots 5 and 7, where the plants appeared stunted.

Degree of lodging. The plants of both varieties did not lodge except in plot 10 of Carreon, where about one half of the plants were lodging at the time of harvest. As soon as the grains of the panicles were formed, the plants in plot 10 began to lodge. The plants in the other plots remained upright till harvest time. This result agrees with Aragon and Cada's (1939) report that Seraup Kechil 36 does not lodge readily.

Comparative susceptibility to pests and diseases. No serious pest or disease was observed to affect the Carreon variety. The Seraup Kechil 36 plants were attacked by the rice stem borer *Schoenobius incertellus* Walker. The larvae bored holes into the stalk, fed on the soft tissues inside the culm, and cut off the passage of the food materials and water supply between the lower and upper portions of the panicles. The panicles of the affected plants were bleached because the grains were empty. The damage was fairly well distributed in all the plots planted to Seraup Kechil 36. The rice bug (*Leptocorisa acuta* Thunberg), another very common rice pest, was observed attacking the rice plants by sucking the contents of the developing grains during the milk stage. A few plants were also observed to have been attacked by false smut (*Ustilaginoidea virens* [Cke.] Tak.). The fungus that caused the disease replaced the kernel of rice with large yellow, orange-brown, or greenish-brown sclerotia. The fungus used up all the food reserved for the development of the grains, pushed the hull apart, and finally exposed the entire fungous mass. Infected panicles were conspicuous, for the fungous masses could be seen several meters from the field.

The damage, however, was insignificant inasmuch as only a few grains of the panicles were attacked.

During the maturity period of both varieties, small flocks of "mayang pula" and "mayang costa" fed occasionally on the rice panicles. These were, however, scared away so that they did little damage. Rats and bats attacked the maturing grains at night.

Comparative uniformity in height of the plants of the varieties. In stand of plants in the field, the Carreon variety was more uniform in height than Seraup Kechil 36. This height is supported by the lower standard error of $\mp$ 1.47 cm. of the former as compared with the $\mp$ 1.61 cm. of the latter. Carreon had an average height of 97.05 $\mp$ 1.47 cm. and Seraup Kechil 36, an average of 92.71 $\mp$ 1.61 cm. The difference was slightly significant in favor of Carreon.

Comparative tillering power of the two varieties. Carreon had an average of 5.4 tillers to a hill, which was significantly higher than the 4.1 of Seraup Kechil 36. Hornilla[6] planted Seraup Kechil 36 under lowland conditions and obtained a mean average of 9.9 and 8.9 tillers to a hill in plots planted to seedlings from the "dapog" and wet-bed seedbeds. This result indicates that Seraup Kechil 36 produces fewer tillers under upland conditions than under lowland conditions.

Blooming periods of the two varieties. Carreon bloomed in 106 days after being broadcast and Seraup Kechil 36, in 167 days. There is a difference of 61 days. The blooming time of Carreon obtained in this experiment is close to the 103 days obtained by Ariaga[7]. The blooming time of 167 days of Seraup Kechil 36, however, is forty days longer than that reported by Aragon and Cada in 1939, although these authors grew Seraup Kechil 36 under lowland conditions. Possibly the insufficient amount of water under upland conditions retarded the normal development of Seraup Kechil 36, resulting in the delayed blooming.

Comparative maturity of the two varieties. There was a great difference in the length of time it took the plants of the two varieties to reach maturity. Carreon was the first to mature. The plants in plots 6, 8, and 10 matured on October 6, 1943, whereas those in plots 1 and 2 matured 14 days later. All plots of Seraup Kechil 36 matured on December 20, 1943, or 207 days after being sown. The writer found Carreon to mature in 132 to 137 days. Ariaga[8] reports 136 days. Seraup Kechil 36 matured in 207 days from sowing. Aragon and Cada in 1939 reported this variety to mature 32 days earlier under lowland conditions. Hornilla[9] also noted that Seraup Kechil 36 from the "dapog" seedbed matured in 154 days.

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[6] *Ibid.*
[7] ARIAGA, *op. cit.*
[8] ARIAGA, *op. cit.*
[9] HORNILLA, *op. cit.*

Comparative yield of the two varieties. Table 1 shows that Carreon had an average yield of 75.40 ∓ 12.79 kilograms to a plot, or an average yield of 1508.00 ∓ 255.80 kilograms a hectare. Computed on 44 kilograms to a cavan of palay, the yield of Carreon was 34.27 ∓ 5.33 cavans to a hectare. Seraup Kechil 36 gave an average yield of .1730 ∓ 0.0495 kilogram to a plot, or an average yield of 3.4600 ∓ 0.9900 kilograms a hectare. In terms of cavans of palay, the yield of Seraup Kechil 36 was .0786 ∓ 0.0225 cavan a hectare. Table 1 also shows that Carreon had an average of 93.214 ∓ 0.898 per cent of developed grains to a plot, whereas Seraup Kechil 36 had an average of 72.288 ∓ 4.837 per cent a plot. The difference in the mean yields of Carreon and Seraup Kechil 36 was very highly significant in favor of Carreon.

The yield of Seraup Kechil 36 of .0786 ∓ 0.0225 cavan a hectare under upland conditions was much lower than the 68.63 cavans obtained by Aragon and Cada in 1939 and the 64.5 cavans obtained by Calma and Cada in 1941 under lowland conditions. The failure of Seraup Kechil 36 may be attributed to several causes. One of the most important is that moisture in the soil under upland conditions was probably not sufficient to maintain the normal development of Seraup Kechil 36. Under the upland conditions in this experiment Seraup Kechil 36 became stunted, failed to produce many tillers, bloomed and matured late, and produced a large percentage of undeveloped grains. The panicles were short and had plenty of empty grains.

The low yield of Seraup Kechil 36 may be attributed also partly to pests and diseases, especially to birds and bats. Since this variety was the only one growing in the vicinity at that time, it was the only source of food of these pests.

Percentage of milling. Seraup Kechil 36 had a higher percentage of milling than Carreon.

SUMMARY

1. There was no difference in the vegetative vigor of the plants of both varieties in their earlier stages, but later Carreon became more vigorous than Seraup Kechil 36.

2. As a rule, the plants of both varieties did not lodge.

3. Under the upland conditions in this experiment, the pests and diseases were more harmful to Seraup Kechil 36 than to Carreon.

4. The plants of Carreon were taller and more uniform in height than those of Seraup Kechil 36.

5. Carreon flowered in 106 days and matured in 132 to 137 days after sowing, whereas Seraup Kechil 36 bloomed in 167 days and matured in 207 days.

6. Carreon had a higher percentage of developed grains but a lower milling percentage than Seraup Kechil 36.

7. Under the upland conditions of this experiment, Seraup Kechil 36 was a failure.

TABLE 1

Yields of the two varieties of rice tested under upland conditions

PLOT	SERAUP KECHIL 36			CARREON		
	DEVELOPED GRAINS	DEVELOPED AND UNDEVELOPED GRAINS	DEVELOPED GRAINS	DEVELOPED GRAINS	DEVELOPED AND UNDEVELOPED GRAINS	DEVELOPED GRAINS
	kgm.	*kgm.*	*per cent*	*kgm.*	*kgm.*	*per cent*
1	.090	.140	64.29	60.0	64.0	93.75
2	.075	.125	60.00	64.0	68.4	93.57
3	.200	.275	72.73	53.4	57.0	93.68
4	.350	.400	87.50	75.0	81.2	92.36
5	.150	.195	76.92	124.6	134.4	92.71
Variety total	.865	1.135	361.44	377.0	405.0	466.07
Variety mean	.1730±0.0495	227±0.0506	72.288±4.837	75.40±12.79	81.00±13.92	93.214±0.898

MAKING CORN-TAPILAN SILAGE

José P. Esguerra
Of the Department of Animal Husbandry

Corn silage was first produced in the College in 1929 when the dairy and work animals increased to such a number that the pasture areas became inadequate to supply the needed forage during the dry months. Then making silage became part of the yearly routine to provide succulent feed to the dairy and work animals during the hot months, from as early as February to as late as June, or until the pasture recovered from the effects of the dry season.

Silage is succulent feed and well relished by cattle, Philippine carabaos, and Murrah buffaloes. The success in corn ensiling (Esguerra, 1940) stimulated the search for increasing the feed value of the corn silage. Corn and legumes grown together and then ensiled caused the nutritive value of the silage to become narrower than corn alone, and they increased the productive capacity of the land because both the corn and the legumes are given to the animals after ensilage. The growing of corn and legumes together will not deplete the land of its nitrogen fertility sooner than when corn alone is grown, because the legume will replenish to some extent the nitrogen absorbed by the corn. According to King (1900), silage is relatively cheap and thoroughly relished by animals. It deteriorates little with age, and can be compactly stored.

Legume in the form of hay or silage is a nutritious animal feed. Although it is easier to make hay than silage, legume should be stored in the form of silage which can be made at any time of the year. Silage is palatable; it requires less storing space than hay, and is safe from fire. However, the correct method of ensiling legume should be developed so as to produce a wholesome silage of good aroma.

The high protein content of the legume accounts for the difficulty in ensiling it. Preserving materials rich in carbohydrates are needed to combine with legume to inhibit the growth of the putrefying bacteria which cause the spoiling of the ensiled legume. Mineral acids are also used as preserving materials. It was pointed out by Reed and Fitch (1917) that alfalfa in combination with corn chop, molasses, or straw does not make good silage; however, Bohstedt, Petterson, and Duffee (1940) reported that ensiling soybeans in one to one ratio with corn or sweet sorghum resulted in a good product. Lush and Barr (1930) found that the Holstein cow consumes 2.75 tons of silage, and the Jersey, 2.25 tons in five months with very little pasture.

[1] Experiment Station Contribution No. 1499. Read before the Los Baños Biological Club, August 22, 1947.

In the local method of making legume silage, the preservative is mixed with the legume through the ensilage cutter, or applied directly to the cut material as it is thrown into the silo. In the study to develop a method of ensiling legume, using corn forage as preservative, the corn and the legume were ensiled together because the two crops were grown at the same time in the same rows and harvested together.

MATERIALS

The materials used in this study were the following:

Land, 4.25 hectares, valued at ₱250 a hectare. The rent was ₱30 a year. The land was used for six months.

A silo, 8 ft. × 27 ft., costing ₱1,151.76 and calculated to last for 50 years was used for six months.

Another silo, 10 ft. × 33 ft., costing ₱1,375.21 and calculated to last for 50 years, was used for six months.

A Fordson tractor, the cost of which was ₱1,932.75 and calculated to last for 10 years, was used for 13 days.

A blower-cutter calculated to last for 10 years and costing ₱723 was used for only nine days, but the charges made were for six months.

Four bull carts each valued at ₱90 were used for nine days; they were calculated to last for four years.

Seven locally made plows each valued at ₱15 were used for two days; they were calculated to last for two years.

Two bamboo harrows each valued at ₱5 were used for four days and a half; they were calculated to last for two years.

One Fairbanks scale, 750-kgm. capacity and costing ₱250, was used for two hours.

Work bullocks and carabaos were used in tilling the area, each earning 50 centavos a day.

PLAN OF STUDY

The study was undertaken in connection with the corn ensiling project of the College. The field which supplied the material for the small silo was planted to corn and tapilan every year until the desired combination of the two crops was obtained.

The study was begun in 1933. The corn and the tapilan (*Phaseolus calcaratus* Roxb.) were planted at the same time and in the same rows. Very few tapilan vines lived because they were overcrowded by the corn. In 1934, the tapilan was planted one week ahead of the corn. Although a large number of the legumes survived, the plants were stunted owing to overcrowding by the corn. In 1935, the tapilan was planted two weeks ahead of the corn, but although the vines developed better than in the previous two years, still the leaves were scanty for ensilage. In 1936, the tapilan was planted three weeks ahead of the corn. Many stems and leaves developed and the corn plants served as trellis for the vines. In all

these cultures, the corn and the tapilan were planted 80 cm. apart in the rows and 100 cm. between rows so as to produce normal ears. All crops raised from the start of the study were ensiled.

In 1936, one 2-hectare lot and in 1938, another two 2-hectare lots were planted to tapilan and corn.

In addition to the harvests from the 6 hectares used in this work, harvests from 1.5 ha. in 1936 and 2.75 ha. in 1938 were also ensiled. The expenses incurred on the unused area of the fields were deducted in the computation of the data.

The study was done during the rainy months because tapilan is dwarfed in the dry months and does not produce enough material for ensiling.

Work animals and locally made plows and harrows were used in the preparation of the ground, furrowing, cultivation, and hilling of the plants.

Men cut the crop with bolos, and work animals and bull carts hauled it.

A Fordson tractor was used to operate the blower-cutter.

Cost of ensiling was computed on 6 per cent of the cost of the silos and equipment and 50 centavos a day for the use of each animal.

Samples of silage from the two silos were analyzed by the Department of Agricultural Chemistry for the proximate nutriends they contained.

The silage made from this study was fed to the dairy and work animals.

FARM OPERATION

The land for the 1936 culture was plowed on March 24 and 27, harrowed on March 29 and 30, replowed on April 27 and 28, and harrowed on May 3 and 4. One of the fields of the 1938 culture was plowed on March 17, 18, and 19, harrowed on March 28, replowed on April 25 and 26, and harrowed on April 29. The other field was plowed on March 29 and 30, harrowed on April 3 and 4, replowed on April 27 and 28, and harrowed on April 30.

The tapilan for the 1936 culture was planted on May 12, and the corn on June 2, an interval of 21 days. The tapilan for the 1938 culture was planted on May 4, and the corn on May 28, an interval of 24 days. Two weeks after the corn was planted, the young corn and tapilan were thinned to three and four plants to the hill, depending on the vigor of the young shoots. The plants were hilled two weeks later.

ENSILING

The small silo was used for the 1936 crop and the big silo for the 1938.

The 1936 crop was ensiled from August 24 to 26, when the corn was 84 days old and the tapilan, 104 days. The 1938 crop was

ensiled from August 17 to 22, when the corn was 81 days old and the tapilan 105 days. The corn was in the glazing stage but the tapilan was not yet in bloom.

While the small silo was being filled, 17 men were employed daily for three days. Four bull carts and four carabaos were used during the first two days, and two bull carts and two carabaos on the third day. For the big silo, 16 men were employed daily for five days and 17 men on the last day. Four bull carts and four carabaos were used for five days, and three carts and three carabaos on the last day.

As the silos were being filled, 10 carts of the forage from each culture were cut from different places. The corn and the tapilan were separated and the proportion of one to the other was determined.

RESULTS OF THE STUDY

Table 1 gives the itemized cost of making the corn-tapilan silage. The cost of the silage made in the small silo was ₱225.63, and that in the big silo, ₱374.95.

Table 2 gives the quantity of silage made and the cost of producing it. From the small silo, 14,830.7 kgm. of good silage was removed, and from the big silo, 34,262.4 kgm. The total production was 49,093.1 kgm. at a cost of ₱600.58.

Table 3 compares the nutrient contents of corn-tapilan silage with those of corn silage. The dry matter, fats, and carbohydrates of the corn silage were higher than those of corn-tapilan, but the protein content of the latter was more than twice that of the former, and the crude fiber was lower.

The proportion of the corn forage to tapilan vines was 75.4 kgm. of corn to 100 kgm. of tapilan, or a ratio of 1 to 1.34.

The production of silage to the hectare was 11.55 tons, and the cost of producing one ton of the silage was ₱12.23. The study was conducted before the war; hence, the production cost of a ton of silage was low.

According to Lush and Barr (1930), one Jersey cow consumes 2.25 tons of silage in five months, or an average daily consumption of 15 kgm. The Jersey and Batangas cattle being about the same in size, the silage consumption of the two breeds of cattle may be assumed to be the same. On the basis of Lush and Barr's figures, the 11.55 tons of silage produced in one hectare can maintain five Batangas cows in five months, and the 49,093.1 kgm. of silage produced in the two silos, from materials grown on 4.25 ha. of land can maintain 21.8 cows for five months. Ensiled forage from 4.25 ha. can therefore maintain 9.2 cows for a year, whereas only 4.2 cows can be pastured on the same area of land. Under Los Baños conditions, maintenance of one cow for one year is considered to require one hectare of pasture.

CONCLUSIONS

1. The cost of producing 49,093.1 kgm. of corn-tapilan silage was ₱600.58, of which ₱228.67, or 38.07 per cent, represents the cost of producing the forage; ₱137.36, or 22.88 per cent, the cost of filling the silo; and ₱234.55, or 39.04 per cent, the charges for silos, equipment, and miscellaneous expenses.

2. The production of a hectare of forage before the war was 11.55 tons, and the cost of producing one ton of the silage was ₱12.23.

3. The proportion of 1 part of corn forage to 1.34 parts of tapilan vines made good silage.

4. Proximate analysis of corn-tapilan silage gave 4.56 per cent protein, whereas corn silage gave 2 per cent. The crude fiber was 7.13 per cent in corn-tapilan and 9.13 per cent in corn silage. The dry matter, fats, and carbohydrates of the corn-tapilan silage were lower than those of the corn.

5. Corn-tapilan silage from 4.25 ha. of land can feed 9.2 cows a year.

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TABLE 1

Cost of producing corn-tapilan silage

ITEMS	1936	1938	TOTAL
	pesos	*pesos*	*pesos*
Cost of producing corn-tapilan forage	74.83	153.84	228.67
Labor cost of filling the silos	40.31	97.05	137.36
Miscellaneous expenses, including charges on silos, machinery, carts, and fuel	110.49	124.06	234.55
TOTAL	225.63	374.95	600.58

TABLE 2

Total silage made and cost of making it

DATE OF CULTURE	PRODUCTION		TOTAL ENSILED MATERIAL	COST OF GOOD SILAGE	GOOD
	GOOD SILAGE	SPOILED SILAGE			
	kgm.	*kgm.*	*kgm.*	*pesos*	*per cent*
1936	14,830.7	2,914.1	17,744.8	225.63	80.08
1938	34,262.4	2,822.1	37,084.5	374.95	91.83
TOTAL	49,093.1	5,736.2	54,829.3	600.58	

TABLE 3

Proximate analysis of corn-tapilan and corn silage

NUTRIENTS	CORN-TAPILAN SILAGE			CORN SILAGE
	1936	1938	Average	
	per cent	*per cent*	*per cent*	*per cent*
Moisture	70.81	68.59	69.70	59.71
Fats (ether extract)	0.74	0.89	0.82	1.02
Ash	3.00	3.25	3.12	3.13
Protein (N × 6.25)	4.26	4.86	4.56	2.00
Crude fiber	6.49	7.77	7.13	9.13
Carbohydrates (N.F.E.)	14.70	14.64	14.67	25.01
TOTAL	100.00	100.00	100.00	100.00

THE RECENT IMPORTATION OF LIVESTOCK FROM PAKISTAN [1]

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One of the largest single importations of breeding stock of large animals by the Philippine government arrived in Manila on the *M/V* Hoegh Silvercrest on July 18, 1947. The boat left Karachi, Pakistan, on June 10, 1947. This shipment included the Murrah breed of Indian buffaloes, Red Scindi cattle, and Tharparkar cattle. The total cost upon landing in Manila was approximately a quarter of a million pesos.

Previous to that importation, three shipments of Red Scindi cattle had come to Manila. The first importation was made by the Bureau of Animal Industry. It arrived in February, 1932, and consisted of one bull and seven cows. The second consignment of one bull and three cows arrived in the College of Agriculture, University of the Philippines, for which it was imported, in December, 1933. The third shipment came in October, 1934. It included two bulls, thirty-six cows, and sixteen calves, all belonging to the Bureau of Animal Industry[2].

MEN BEHIND THE IMPORTATION

At the instance of Dr. Vicente Ferriols, director, and Dr. Pedro S. Sales, chief, division of animal husbandry, Bureau of Animal Industry, Dr. Estefano C. Farinas, supervising zootechnist of the same bureau, was directed to purchase large animals in Pakistan to restock this country with improved breeds. The work of Dr. Farinas was not a simple one. He wrote: "This job of exporting is simply exasperating, annoying, and discouraging. Even with my optimistic build of mind, the burden of responsibility is almost too heavy to bear and is causing me a lot of worries.... I trust that I have done what man can do..." He also mentioned that "there are many items of expense, too rigid regulations, too many forms to fill, too many stamps required."

As expected, the animals selected by Dr. Farinas are on the whole satisfactory. Many of them, in fact, are of exceptional individuality. Some have good pedigrees behind them. The Red Scindis have a uniform red color, the majority of them having a

[1] General Contribution No. 787. Data obtained from the Bureau of Animal Industry.

[2] VILLEGAS, VALENTE. 1935. The Red Scindi cattle imported by the College of Agriculture. Philippine Agriculturist **24**: 16-21.

shade of blood red. Very few have dark shades on certain parts of the body. The Murrahs are of two colors: the majority bear the standard jet black; a few are brown.

ORIGIN AND PERFORMANCE OF RED SCINDI AND THARPARKAR CATTLE[3]

Red Scindi cattle are an improved breed of dairy cattle in Pakistan. Their native home is in the district around Karachi and in the Las Bela region of Baluchistan. They are red or fawn, some showing white spots on the face and dewlap. In their native home the average record of production of one group amounted to 1,696.1 liters of milk in 279 days, and that of another group 1,731.8 liters in 325 days. In the College of Agriculture, University of the Philippines[4], the average daily milk production of all cows on the basis of 300 days was 4.6 liters, and the average lactation was 345 days. One of the cows gave the highest daily milk yield of 10.1 liters. Another high milk-producing cow gave an average of 6.1 liters of milk a day in 300 days. Her production at full lactation was on an average of 2,136.1 liters.

The Tharparkar is a new breed of Indian cattle to reach our shores. Like the Murrah and the Red Scindi, it is a dairy breed and is claimed to be good also for work purposes. It comes from the dry regions southwest of Sind and from adjoining areas. It is medium-sized and fairly robust in conformation. Its color is silvery gray. The average production in one group was 1,583.5 liters of milk in 261 days, and 1,785.5 liters in 267 days in another group. As much as 3,188.7 liters in one lactation has been obtained.

NUMBER AND PURCHASE PRICES OF ANIMALS

This importation consisted of 49 Murrah carabaos, 165 Red Scindi cattle, and 120 Tharparkar cattle. Twelve Murrah carabao cows, one Murrah carabao calf, and one Red Scindi heifer were refused passage and were, therefore, left behind. Seven of the Murrahs were bulls and 45 were cows. Among the Red Scindis, 10 were bulls, 54 cows, and 78 heifers. There were three Tharparkar bulls, 51 cows, and 43 heifers. The Murrah bulls ranged in price from ₱610 to ₱732, the average being ₱671. The prices of the females varied from ₱488 to ₱732, the average being ₱603.22. The Red Scindi bulls were bought at a minimum price of ₱549 and an average price of ₱829.60, the highest priced costing ₱1220. The Red Scindi cows cost from ₱457.50 to ₱732, the average price being ₱534.88. The average price of the Red Scindi heifers was ₱176, the range being from ₱90 to ₱305.

Of this importation, the College of Agriculture of the University of the Philippines received one Murrah carabao bull, two Murrah carabao cows, four Red Scindi cows, and eight Red Scindi

[3] Philips, Ralph W. 1944. The cattle of India. Jour. Hered. 35: 273-288.
[4] Sarao, Felix B., and Miguel Manresa. 1941. Performance of the Red Scindi cattle at the College of Agriculture. Philippine Agriculturist 30: 541-547.

heifers. Dr. Farinas gave his personal attention to the selection of the mature animals except the Murrah bull, which, together with the Red Scindi heifers, was acquired later. The representative of the College of Agriculture was given the privilege to select these animals upon landing in Manila. For all these, the College of Agriculture is grateful to the officials of the Bureau of Animal Industry for their generosity and cooperation.

COSTS

Aside from the expenses of the purchasing mission and minor disbursements, the total expenditures incurred in bringing the animals to this country amounted to ₱242,943.71. The total price of the animals was ₱118,462, which was 48.7 per cent of the total cost. The purchase price of the Red Scindi cattle imported in 1933 by the College of Agriculture of the University of the Philippines was 17.8 per cent of the total expenses[5]. The freight amounted to a total of ₱70,940, or 29.2 per cent of all expenses. The charges per head were ₱300 for adults, ₱160 for heifers, and ₱80 for calves. In the case of the animals of the College of Agriculture just referred to, the freight charges both on land and on the sea amounted to 16.2 per cent of all charges. For three days the animals were kept in the stockyard at the port before shipment. The expenses there, including feeding, amounted to ₱26,572.21, or 10.9 per cent of the total. Purchased for the animals during voyage were 2,602 bags of feed valued at ₱14,060.50, or 5.78 per cent. In addition, feed and milking cans, buckets, and over 27 meters of coir matting were purchased for the voyage. These, and the expense of preparing the animals for shipment together cost ₱7,082.71, or 2.91 per cent. A deposit of ₱610, or 0.25 per cent, was made in the Customs Office for levies, wharfage, and clearance fees. The fee for vaccinating the animals was ₱328.29, or 0.13 per cent. The government also charged marketing fees amounting to ₱1,586.00, or 0.65 per cent.

ADDITIONAL EXPENSES

Mr. Rutton D. Patel was placed in charge of the animals during the voyage. He had 14 attendants under him. Their passage cost ₱2,970, or 1.22 per cent of the total expenses. Also, a head tax of ₱16 was levied, or a total of ₱240, which made 0.10 per cent of the expenses. Fees for medical certificates of the men amounted to ₱91.50, or 0.04 per cent.

[5] VILLEGAS, V. *op. cit.*

A REVIEW: SUCCESSFUL POULTRY MANAGEMENT[1]

Successful Poultry Management is a book that vocational students in high schools will find valuable as a reference. Although it is intended primarily for use in vocational schools, college students taking their first course in poultry husbandry will also find the book useful. The author, Dr. Morley A. Jull, is an authority on poultry husbandry and well known as a researcher, teacher, and popular writer on things about poultry. Dr. Jull being equipped with such a rich background, it is not surprising that his book should contain up-to-date information on poultry husbandry practices based upon the latest knowledge of facts drawn from results of researches and from experience obtained through actual contact with successful poultry farmers. For this reason, flock owners will also find the book useful as a guide.

The subject matter covered in the twelve chapters of the book has been arranged from the point of view of a beginner in poultry raising, so that each step involved from the production of poultry and eggs to the marketing of the products is discussed in detail. For instance, the need for good stock is discussed in Chapter I, for "success in the poultry business depends very largely upon the economic qualities which birds possess." The next chapter gives suggestions on how the quality of the stock can be maintained, and Chapter III offers suggestions for the improvement of the efficiency of the stock. The next two chapters discuss important problems on renewing the flock and the proper care of the young stock in order that they may become efficient producers.

Chapter VI will provide Philippine poultry raisers with valuable pointers on keeping layers comfortable and on efficient management of poultry through proper housing conditions. As the book has been written for temperate regions, poultry raisers in this country should adapt their needs to the local environment. Parts of Chapters VII and VIII on the feeding of chickens for production should serve as an excellent guide, for whether chickens are raised in the tropics or under temperate conditions, and the feeds used may differ, the feeding principles remain the same. Chapter IX should be of special interest to Philippine poultry raisers because it deals on the control of loss from mortality and other causes, including losses due to thefts, which undoubtedly constitute an enormous loss to flock owners every year.

Although at present the marketing of eggs and poultry is still not a problem to local poultry raisers, Chapters X and XI should

[1] JULL, MORLEY A. 1943. Successful Poultry Management, xi + 467 p., 187 fig. New York: McGraw-Hill Book Company, Inc. General Contribution No. 788.

be of interest to them for the important suggestions that are given in these chapters. The last chapter should be read by one who has been infected by the "chicken fever" to find if he has the necessary qualities to make a success of the chicken business, and to enable him to know how success may be attained.

The whole book is a discussion of successful management of poultry as a business enterprise, supplemented with carefully selected illustrations distributed throughout the book.

Successful Poultry Management should be a welcome addition to the library of everyone interested in the poultry industry.

F. M. Fronda
Of the Department of Animal Husbandry

COLLEGE AND ALUMNI NOTES

Dr. Francisco O. Santos, Professor and Head of the Department of Agricultural Chemistry and president of the Philippine Association of Nutrition, delivered on November 21, 1947, the opening address in the first nutrition conference of the association held on November 21 and 22 at Villamor Hall, University of the Philippines, in Manila. He also read a paper on research problems in nutrition in the Philippines on November 22. Professor Santos was recently appointed member of the Institute of Nutrition.

Mr. Theodore R. Gardner, of the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, and Dr. W. Harry Lange, of the University of California, were in the College on November 21 to 27, 1947. Mr. Gardner was in search of parasites of the rhinoceros coconut beetle, and Dr. Lange, of parasites that may be used against a *Bronthispa* that attacks the coconut in the Marianas Islands. Their work is under the auspices of the U. S. Navy (Marianas) for the Pacific Science Council. Dean L. B. Uichanco and Dr. S. M. Cendaña extended to the visiting entomologists all possible help.

Two Dutch and one Bornean delegates to the ECAFE conference in Baguio visited the College on December 11, 1947. They were Dr. J. van der Ploeg, chief of the agricultural service; Dr. D. Groenveld, chief of the research division of the Department of Economic Affairs of the Netherlands East Indies Government; and Mr. Boerhanoedin, of Borneo. The visitors were accompanied by Mr. Francisco G. Galang, of the Bureau of Plant Industry.

Dean L. B. Uichanco was recently appointed member of the Plant Quarantine Board by the Secretary of Agriculture and Natural Resources.

President B. M. Gonzalez of the University of the Philippines was appointed chairman of the board of regents of the Institute of Science. Among the other College alumni with him on the board are Undersecretary of Agriculture and Natural Resources José S. Camus, Dean Leopoldo B. Uichanco, Dr. Manuel L. Roxas, and Dr. Felipe T. Adriano.

President Gonzalez was appointed chairman of the National Housing Commission, member of the Government Enterprises Council, and member of the National Commission on Educational, Scientific, and Cultural Matters.

In the one-hundred-and-seventy-fourth scientific meeting of the Los Baños Biological Club on January 16, 1948, in the Agricultural Engineering Lecture Hall, the following papers were read and dis-

cussed: "Photochlorination of Homologous Series of Fatty Acids from Coconut Oil" by Mr. Enrique O. Bondoc, of the Department of Agricultural Chemistry, and "A Study of the Agronomic Characters and Yield of Seraup Kechil 36 and Carreon under Upland Conditions" by Mr. Federico V. Ramos, of the Department of Agronomy.

In the one-hundred-and-seventy-fifth scientific meeting on February 20, 1948, Mr. Saguiguit read a paper on "Educational and Occupational Pursuits of Former Students in the Batangas and Ilocos Norte High Schools" by Dr. F. M. Sacay, of the Department of Agricultural Education, Mr. Gil F. Saguiguit, of the Department of Agricultural Economics, and Mr. Faustino Brual. Dr. Capinpin read a paper on "Mendelism in Tomato," by Dr. José M. Capinpin, of the Department of Agricultural Botany, and Mr. Saturnino C. Cauton.

In the one-hundred-and-seventy-sixth meeting on March 12, 1948, the papers read were: "Refining of Coconut Oil by Means of Some Alkalies" by Miss Rosy R. Baltazar, Miss Luisa Mondoñedo, and Dr. Julian Banzon, of the Department of Agricultural Chemistry; and "College 39, a New Promising Variety of Sugar Cane" by Dr. Valeriano C. Calma, of the Department of Agronomy.

In the meeting of the Society for the Advancement of Research on February 6, 1948, Dr. Rafael B. Espino, was elected active member and Mr. Enrique O. Bondoc, Mr. Leopoldo S. Castillo, Miss Nena A. Rola, and Miss Luz A. Uichanco were elected associate members. Drs. Gloria D. Manalo and Artemio V. Manza, members of the Society of the Sigma Xi, were taken in as active members by affiliation.

The Philippine delegation to the Food and Agriculture Organization Conference of the United Nations held in Baguio from February 23 to March 17, 1948, included the following alumni of the College: Undersecretary of Agriculture and Natural Resources José S. Camus,' 14, chairman of the Philippine Committee of the FAO and vice-chairman of the Philippine delegation; and alternate delegates Dr. Manuel L. Roxas, '11, on nutrition, Director of the Bureau of Fisheries Deogracias Villadolid, '19, on fisheries, and Dr. Amando M. Dalisay, '37, of the Department of Foreign Affairs, on economic matters and general coordination. The technical advisers included Mr. Cornelio V. Crucillo, '25, and Mr. Victorino Borja, '34, on rice production; Dr. Francisco O. Santos, '19, on nutrition; and Dr. Francisco M. Sacay, '25, on economics of agriculture.

Dean L. B. Uichanco, guest speaker at the meeting of the Sigma Xi Club of the Philippines held in the Institute of Science in Manila on March 13, 1948, spoke on "The Present Status of Research in the Philippines."

On March 31, 1948, the College faculty recommended to the University Council the graduation of the following seniors: Patricio Y. Agbagala, Victorino C. Andrion, Marcia R. Arnaldo, José B. Baclig, Mario C. Belisario, Antonio D. Bustrillos, Crispin E. Cabanilla, Renato I. Capinpin, Leopoldo S. Castillo, Pedro C. Clemente, Magdaleno R. Elazegui, Luis F. Guingona, Oscar G. Guirnalda, Eugenio A. Jongo, Adolfo Lioanag, Restituto R. Lopez, Lelis C. Loria, Avelino B. Manuel, Eugenio V. Mendoza, Onofre C. Mendoza, Gregorio B. Miguel, Florentina C. Ortiz, Eduardo S. Panimbatan, Ladislao C. Querubin, Magfedio M. Raymundo, Nena R. Rola, (*cum laude*), Leodegario J. del Rosario, Guillermo P. Santos, Teodoro M. Tiglao, Illuminado G. Valencia, Luciano C. Valencia, and Teodomero M. Yñiguez.

The faculty awarded the Joaquin J. Gonzalez Medal to Miss Luz A. Uichanco, *magna cum laude*, of the class of 1948, for having obtained the highest academic average for the entire course.

The faculty also recommended the graduation of Teofilo M. Fran for the title of Associate in Agriculture.

Dr. Valente Villegas, Head of the Department of Animal Husbandry, was appointed by President Quirino as Philippine delegate to the First International Congress of Physiology and Pathology of Animal Reproduction and of Artificial Insemination held in Milan, Italy, from June 23 to June 30, 1948. Dr. F. M. Fronda was designated acting head of the department during the absence of Dr. Villegas.

Dr. Faustino S. Mensalvas, a 1939 graduate of the College of Veterinary Science, has been appointed instructor in the Department of Animal Husbandry.

IN MEMORIAM

Mr. Cecilio A. Pangga, '38, assistant instructor in the U. P. Rural High School, died on June 7, 1948, and was interred in the Los Baños cemetery on June 9. When taken ill, Mr. Pangga was preparing to leave for the United States to pursue graduate studies in rural education at Cornell University. He was appointed U. P. fellow by the Board of Regents on January 23, 1948.

THE EXPERIMENT STATION

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The price of the circulars listed above is thirty centavos (₱0.30) each.

A HANDBOOK OF PHILIPPINE AGRICULTURE ..... ₱5.00

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SWORN STATEMENT

(Required by Act No. 2580)

The undersigned, business manager of THE PHILIPPINE AGRICULTURIST, published quarterly in English at the College of Agriculture, College, Laguna, after having been duly sworn in accordance with law, hereby submits the following statement of ownership, management, circulation, etc., which is required by Act 2580, as amended by Commonwealth Act 201:

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J. M. CAPINPIN
Business Manager

Subscribed and sworn to before me this 20th day of September, 1948, at Los Baños, the affiant exhibiting his Residence Certificate No. A2939087 issued at Los Baños, Laguna, on January 5, 1948.

AURELIO C. ALMAZAN
Municipal Mayor
Los Baños, Laguna